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A JOURNAL OF HIGHWAY RESEARCH

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Dual-purpose commercial parking structures, with street-level shops, help solve the down-town parking problem

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E. A. STROMBERG, Editor

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Contents of this publication may be reprinted. Mention of source is requested.

Evidence of the parking problem: cars double-parked on the street waiting for space in a lot that is already full.

Some Travel and Parking Habits Observed From Parking Studies

BY THE HIGHWAY TRANSPORT RESEARCH BRANCH, BUREAU OF PUBLIC ROADS

Reported by S. T. HITCHCOCK, Assistant Branch Chief, and R. H. BURRAGE, Highway Engineer

FULL economic benefits of urban arterial and expressway street and highway developments cannot be realized if there is no place to park the motor vehicle at the terminus of the trip. The planning of adequate terminal facilities for the parking of cars or the loading and unloading of trucks is consequently an integral part of any plan for urban highway transportation improvements.

In many cities the parking problem in the downtown area was serious before the war, and with the postwar increase in motor-vehicle usage it has reached alarming proportions. In an effort to evaluate the parking load under present conditions—a load which would most certainly increase with the improvement of arterial streets and the construction of expressways leading to and from the downtown area—many cities have made studies of traffic volumes and travel habits as they related to trip destinations and parking in the downtown area.

If a parking study is to be of value in planning for the development of off-street parking lots or garages, or in determining reasonable restrictions for curb usage, certain basic information is necessary:

1. Location and existing supply of parking spaces.
2. Usage of existing parking spaces.
3. Location and extent of existing demand.
4. Cordon count of inbound and outbound traffic to determine total parking load.
5. Influence of large traffic attractions on parking demand.
6. Parking habits.
7. Adequacy of existing laws and ordinances.
8. Limitations of existing administrative responsibility.
9. Financing methods.

Riding past the "full-up" parking lots and making endless circuits of the block in search of a vacant curb space, every motorist has become personally aware of the critical downtown parking problem. To resolve this problem, detailed information on all its ramifications is first needed; and in 46 cities, ranging in population from under 6,000 to more than a million, comprehensive parking studies of the central business districts have been undertaken or completed. From these studies, conducted according to a common basic pattern, some interesting observations on parking habits have been drawn.

It has been found that the number of available parking spaces and the number of vehicles parked, in proportion to population, decrease rapidly as the size of the city increases—there being seven times as many spaces and thirteen times as many parked vehicles, per 1,000 population, in the small cities as in the large cities. The central business districts of the small cities generate ten times as much traffic, in the peak half-hour, as those of the large cities, when proportioned to population. The percentage of traffic passing through the central business district during the day as a whole is about the same for all cities, but during peak periods 91 percent of the traffic in large cities does not stop to park. In the concentrated core of the central business districts, space-hour demands for parking exceed the supply by ratios ranging from 1.34 in small cities to 4.67 in the large cities.

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The metropolitan area travel habit studies, which have proved extremely useful in estimating probable desire lines of travel and traffic usage of selected route locations, provide some information on parking practices.[1] The size of the sample, however—usually 5 or 10 percent—proved to be inadequate for the estimating of trip destination volumes for the relatively small areas such as would be usable for determination of location and size of parking facilities.

One specific method of making a parking study, commonly referred to as "cruising," is based on the inspection methods used by police for enforcement of parking regulations. License numbers of parked vehicles are recorded at periodic intervals either from a moving car or by a recorder on foot. This method indicates the usage of space, as to location and length of time parked, within limits of the length of time between recordings. It sacrifices all information on the short-time parker, and does not permit obtaining any information on trip purpose and destination, which is desirable for determining the proper location of parking facilities.

Another method, involving the distribution of return-mail questionnaire cards, has also been used in some spot situations. For a comprehensive analysis of the entire downtown area this is considered to be unsuitable because of the uncertain quantity of returns (seldom exceeding 30 percent) and the lack of statistical control of those returned.

Because of the limitations of these approaches and the need for more specific information for purposes of location selection and capacity design a more comprehensive type of study has been developed,[2] in which the needed data are obtained by direct interview of parkers and by cordon count of all vehicles entering and leaving the area.

Summary of Observations

Analysis of data fully developed in 29 cities and partial information from 17 others, where comprehensive parking studies of the central business districts have been conducted in a uniform manner, reveals many pertinent and interesting trends in parking habits.

As would be expected, the areas of central business districts of cities, where the parking situation is most acute, are relatively small and directly proportional to population—ranging from 0.1 square mile in the small cities to 0.5 square mile in the largest. In relation to population, of course, this range is reversed: the small cities having 0.7 square mile per 100,000 population and the largest, 0.05. Similarly, the total number of parking spaces available ranges from 1,400 in the smallest cities to 10,200 in the largest, while per 1,000 population the spread is in the opposite direction, from 89 to 12.

The number of vehicles parked during the 8-hour business day varies from 7,100, or 446 per 1,000 population, in the small cities, to 30,000, or 34 per 1,000 population, in the large ones. In all cities the proportion of commercial vehicles parked is fairly constant at about 13 percent.

The parking problem is most acute, of course, in the core of the central business district. There, the space-hour demand ranges from 3,500 in the smallest cities to 28,600 in the largest cities, while the available supply is from 2,600 to 6,600. The ratio of demand to supply increases from 1.34 in small cities to 4.67 in large ones.

For various reasons, the central business districts of small cities are proportionately greater traffic generators than those of the large cities. The in-and-out traffic in the peak half-hour, per 1,000 population, ranges from 139 vehicles in the former to only 14 in the latter. The ratio of the peak-hour traffic to that in the average hour, however, is constant regardless of population, the peak-hour volumes being about one-third greater. The proportion of traffic passing through the central business districts during the business day varies but little for cities of different size, but traffic passing through in the peak half-hour ranges from 59 percent in the small cities to 91 percent in the large cities.

As a reflection of the different characteristics of small and large cities, it was found that 56 percent of the vehicles in the former and 28 percent in the latter parked less than 30 minutes; while 8 percent and 25 percent, respectively, parked 4 hours or more. Similarly, 70 percent of the parkers in small cities and 46 percent in the large cities walked less than a block to their destinations; while 9 percent and 30 percent, respectively, walked two blocks or more.

Regardless of the purpose of trip, the length of parking time increased in direct relation to the size of the city. The average time parked where "work" was the purpose ranged from 3 hours in small cities to over 5 hours in large cities, and similar spreads occurred for "shopping" and "business" purpose parking. Parking time for other purposes varied little, regardless of population.

The psychological advantage of parking meters is indicated by the fact that overtime parking, both in number of occurrences and in excess time parked, is considerably less at metered curbs than at unmetered but time-restricted curb spaces.

Table 1.—*Cities in which direct-interview type parking studies have been made*

City	Population [1]	Year of study	Data available
Decatur, Ind.	5,861	1948	--
Seymour, Ind.	8,620	1948	--
Wabash, Ind.	9,653	1948	--
Columbus, Ind.	11,738	1948	--
Albert Lea, Minn.	12,200	1947	X
Frankfort, Ind.	13,206	1948	X
Huntington, Ind.	13,903	1948	X
Portsmouth, N. H.	14,821	1946	X
Stevens Point, Wis.	15,777	1947	X
Walla Walla, Wash.	18,109	1946	--
Meadville, Pa.	18,919	1948	X
Anderson, S. C.	19,424	1947	X
Lake Charles, La.	21,207	1947	--
Boise, Idaho	26,130	1948	--
Alexandria, La.	27,066	1947	X
Monroe, La.	28,309	1947	X
Easton, Pa.	33,589	1948	X
Kokomo, Ind.	33,795	1948	--
Anderson, Ind.	41,572	1948	X
Lynchburg, Va.	44,541	1948	--
Muncie, Ind.	49,720	1948	--
Corpus Christi, Tex.	70,700	1947	X
Pawtucket, R. I.	75,797	1945	X
Charlotte, N. C.	113,000	1947	X
Wichita, Kans.	127,300	1947	X
Spokane, Wash.	141,400	1947	X
Knoxville, Tenn.	151,800	1946	X
Harrisburg, Pa.	173,400	1946	X
Reading, Pa.	175,300	1947	X
Chattanooga, Tenn.	193,200	1947	X
Jacksonville, Fla.	195,600	1947	--
Nashville, Tenn.	241,800	1946	X
Honolulu, T. H.	245,000	1947	--
Richmond, Va.	245,700	1948	X
Omaha, Nebr.	287,700	1948	--
New Haven, Conn.	308,200	1946	X
Allentown-Bethlehem, Pa.	325,142	1948	--
Toledo, Ohio	341,700	1947	X
Denver, Colo.	384,400	1945	X
Portland, Oreg.	406,400	1946	--
Atlanta, Ga.	442,300	1945	X
Seattle, Wash.	452,600	1946	X
Providence, R. I.	711,500	1945	X
Baltimore, Md.	1,046,700	1946	X
Cleveland, Ohio	1,215,000	1948	--

[1] U. S. census of population, 1940.

The Comprehensive Parking Study

The purposes of a comprehensive parking study have been indicated briefly. Some elaboration is desirable, however, concerning the basic phase of the study operation, that of the interviews with the parkers. The study is as a rule confined to the central business district (or to any other area where parking is a problem), around which the cordon count is made. A direct interview is made with the driver of every vehicle parked in the area. The interviews usually are confined to the hours of the business day, 8 or 10 a. m. to 6 p. m., and hence include the peak of parking and traffic accumulation.

Table 2.—*Area and population relations of central business districts*

Population group	Number of cities	Average population in metropolitan area	Average area of the central business district		
			Square miles		Number of blocks [1]
			Total	Per 100,000 population	
Under 25,000	10	15,400	0.11	0.69	23
25,000–50,000	4	32,600	.13	.41	38
50,000–100,000	2	66,550	.22	.27	36
100,000–250,000	10	176,200	.44	.26	76
250,000–500,000	6	280,700	.46	.12	97
Over 500,000	2	879,000	.54	.05	134

[1] Block dimensions vary from 150 feet to 600 feet.

[1] *Traffic planning studies in American cities*, by J. T. Lynch; PUBLIC ROADS, vol. 24, No. 6, Oct. 1945; and *Highway safety: Driver behavior—key to safe highway design*, by Thos. H. MacDonald; PUBLIC ROADS, vol. 25, No. 7, March 1949.

[2] *Factual guide on parking for the smaller cities*, Public Roads Administration, Sept. 1947; and *Determining parking requirements by means of a study of parking habits*, by S. T. Hitchcock and T. E. Willier; Proceedings of the Highway Research Board, vol. 24, 1944, p. 255.

It would be possible to accomplish the interviewing in one day by using a very large force, but it is preferable to use a small group of trained interviewers and to spread the work over several weeks. This affords advantages from an operating standpoint and produces data more representative of an average day. The cordon count is similarly a composite sample, spread over the same period as the interviews.

The actual interview with each driver requires only about 30 seconds and includes queries to determine trip origin, purpose in making the stop, and the destination to which the parker is going to walk. Data on the location, the time of arrival and departure, the type of vehicle, and the type of parking are obtained by observation. The data permit a determination of accessory but valuable information on turn-over, violation of space and time regulation, and use (and abuse) of loading zones and other special-privilege facilities. The information on how long drivers do park, when coupled with their destinations, provides a reasonably accurate measure of where they would like to park and for how long, if space were available. This is the existing demand.

The inventory of existing parking space and the cordon-count data are summarized and tabulated by manual methods. The interview data, because of the number of items of information involved and the many interrelations desired, are particularly susceptible to machine tabulation. Resultant from these summarizations is the information on generators of parking demand and on the parking characteristics of the motorists. The study of the legal, administrative, and financial aspects of the problem is a staff responsibility, to be integrated with the findings and recommendations from the other phases of the studies.

With the knowledge that the basic volumetric data have been obtained with reasonable accuracy, specific locations and designs for additional facilities may be planned with assurance. The information on parking habits, when correlated with location, may be used to advantage in revising time restrictions, and in the location or relocation of parking meters. It is also basic in determining operating characteristics and capacity for design purposes. The data on truck destinations and parking-time durations will indicate the need for added loading zones or off-street loading space.

Trends Observed From Studies

The direct-interview type of parking study, initiated in 1945, has now been made in 46 cities throughout the country, ranging in population from 5,000 to over 1,000,000 (table 1). Data have been developed fully in 29 of these cities. Since the same procedures were used in each case, it has been possible for the first time to observe some relations of area characteristics, parking habits, travel habits, and traffic volumes.

The data reported in this article represent conditions in cities which have recognized the existence of a parking problem sufficiently acute to warrant an extensive study as a first step toward seeking a solution. In all probability the parking problem is just as serious in a great many other cities; and it may be a mark of greater initiative on the part of the cities that have undertaken these parking studies, rather than of greater need.

Table 3.—*Curb and off-street parking spaces available in the central business district*

Population group	Number of cities	Average number of parking spaces			Spaces per 1,000 population	
		Curb	Off-street	Total	Curb	Total
Under 25,000	9	933	485	1,418	60	89
25,000–50,000	4	1,287	742	2,029	41	65
50,000–100,000	2	1,688	2,401	4,089	23	57
100,000–250,000	9	2,867	3,886	6,751	17	42
250,000–500,000	6	2,961	8,132	11,093	7	28
Over 500,000	[1] 2	2,510	7,675	10,185	3	12

[1] Providence, a city of 253,500 population, has a metropolitan area population of 711,500 with several other fully developed but smaller independent business districts.

The data available from the 29 cities permit analysis in several directions. The summaries presented here are some of the more obvious relations developed in initial analyses. For those cities where the time periods studied were not identical, data were adjusted to a common 8-hour basis (10 a. m. to 6 p. m.).

The data reported are averages for cities in each of six population groups. As will be seen from the tables and graphs, the numerical values of the various elements of the parking problem, as averaged by population groups, show clearly established trends that may be of value to other cities where comprehensive studies have not been made and where complete data are not available.

It had already been suspected that some of the indicated trends or relations might exist, and for some readers personal experience may make some observations appear obvious; but they substantiate many points which heretofore have been largely a matter either of opinion or conjecture. Furthermore, the fact that these data and derivations fall into a pattern indicates that the basic approach to this research problem, or at least the procedural technique, is soundly conceived.

It must be admitted that data for the individual cities are somewhat scattered, in contrast to the uniformity of the population-group averages. Quite probably this incongruity can be accounted for partially by the small number of cities for which data were available; but much more important factors are the character of business and industry and of geographical location, which may differ greatly among cities of the same size. The fact that all of the data as averaged by population groups fall in straight-line or smoothly curved patterns is strongly indicative of their close relation to population.

The Central Business District

The central business district of a city is not a legal entity nor is it generally a clearly defined area. In establishing the limits of such a district for the purposes of a parking study, it was considered as the area where land occupancy is nearly 100 percent, where land

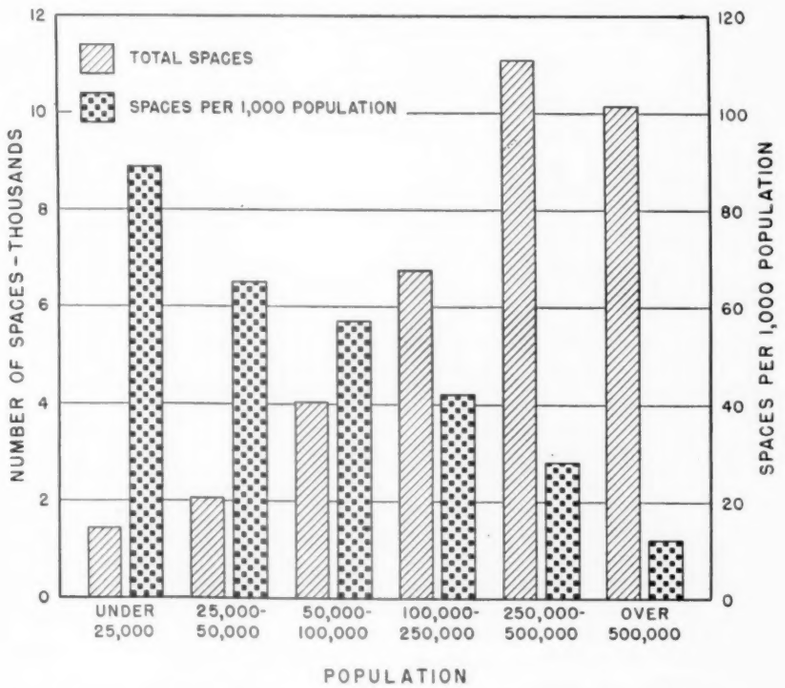

Figure 1.—Parking spaces available in the central business district.

Table 4.—*Number of vehicles parked in the central business district*

Population group	Number of cities	Average number of vehicles parked in 8 hours [1]		Maximum number accumulated [2]		Percentage commercial	Parking accumulation ratio [3]
		Total	Per 1,000 population	Total	Per 1,000 population		
Under 25,000	9	7,097	446	1,050	67	14	1.17
25,000–50,000	4	8,461	267	1,373	43	14	1.13
50,000–100,000	2	11,866	164	2,185	30	11	1.15
100,000–250,000	8	22,130	128	5,447	29	12	1.15
250,000–500,000	5	32,436	83	8,245	21	13	1.15
Over 500,000	2	29,957	34	9,564	11	13	1.11

[1] Total number parking during the period, including those parked at start of period. Adjusted, where necessary, to a common period 10 a. m. to 6 p. m.
[2] At any time during the 8-hour period.
[3] Ratio between the number of vehicles in parking spaces, legal or illegal, in the peak hour and in the average hour.

Table 5.—*Usage of space in the entire central business district, and the relation of demand and supply in the core area*

Population group	Central business district			Core area [1]			
	Number of cities	Present usage in space-hours		Number of cities	Space-hours		Ratio of demand to supply
		Average number	Per 1,000 population		Demand [2]	Supply	
Under 25,000	8	7,692	487	5	3,465	2,552	1.34
25,000–50,000	4	9,988	314	3	4,230	3,043	1.38
50,000–100,000	2	14,632	202	2	4,290	2,964	1.45
100,000–250,000	6	38,802	225	7	17,188	11,285	1.64
250,000–500,000	4	51,578	133	3	20,828	6,505	3.27
Over 500,000	2	65,846	74	2	28,590	6,649	4.67

[1] The core area is that portion of the central business district where land values are generally highest, and where in each block, of several contiguous blocks, the demand for parking space in each exceeds the supply.
[2] Demand for space in the core area, based on destinations of drivers who parked in the central business district.

use is principally business, where curb parking is congested, and to which transit lines converge. It is the area where are found the large stores and office buildings. It often includes some theaters and hotels. It may have a few apartments, but few or no single-unit residences and little manufacturing. Area and population data for the central business districts of a number of cities are shown in table 2.

The determination of the central business district was made locally in each city and, although different engineers established the limits, it is significant to note that the characteristic limits of the central business district have been generally recognized. The trend in size is perhaps to be expected, but confirmation of this trend lends assurance to further analyses in these cities.

In a city where studies have not been made, comparisons with the tabulated data should take into consideration whether the central business district constitutes a problem area greater or less than the average for a city of its population class.

Availability of Parking Space

It is to be expected, as shown in table 3 and figure 1, that as cities grow the supply of curb spaces for parking will decrease proportionally. Curbs are limited in physical extent and as the downtown area grows vertically more curb space is restricted for services in connection with adjacent buildings and for the movement of traffic. It should also be expected that off-street facilities would be developed in a compensating manner, but this apparently has not occurred. It will be noted that the cities of more than 250,000 population have less than one-half as many total parking spaces per capita as cities of less than 100,000 population.

The trends shown, even though expected, lend assurance to the soundness in determination of the limits of the central business district, to the use of the data for comparative purposes in cities where extensive studies have not been made, and to the procedures used in making the study.

Usage of Parking Space

As cities grow, the volume of parking both for the business day and for the peak hour increases. However, when these are expressed in volumes per 1,000 population, as shown in table 4, it is evident that parking usage in the central business districts is proportionately greater in the smaller cities than in the larger cities. This probably is due largely to the higher car ownership and more concentrated business in the smaller cities; and to the extent of mass transit, the presence of numerous suburban shopping areas, and the greater difficulty of finding parking space in the downtown sections, in the larger cities.

The proportion of commercial vehicles parking in the central business district apparently does not vary appreciably in cities of different size. These are the vehicles picking up and delivering goods in the downtown area.

Similarly there is not a great difference, among the various population groups, in the parking accumulation ratio—the ratio of the volume parked in the peak hour of parking and the volume parked in the average hour of the business day. This, perhaps, is traceable to the fact that studies have been made only in cities where a parking problem exists and where, therefore, the load is not far from peak condition all through the business day.

The data in table 4 represent only the volume of parking under present conditions and undoubtedly are not representative of what the trends might be if better traffic service and parking facilities were available.

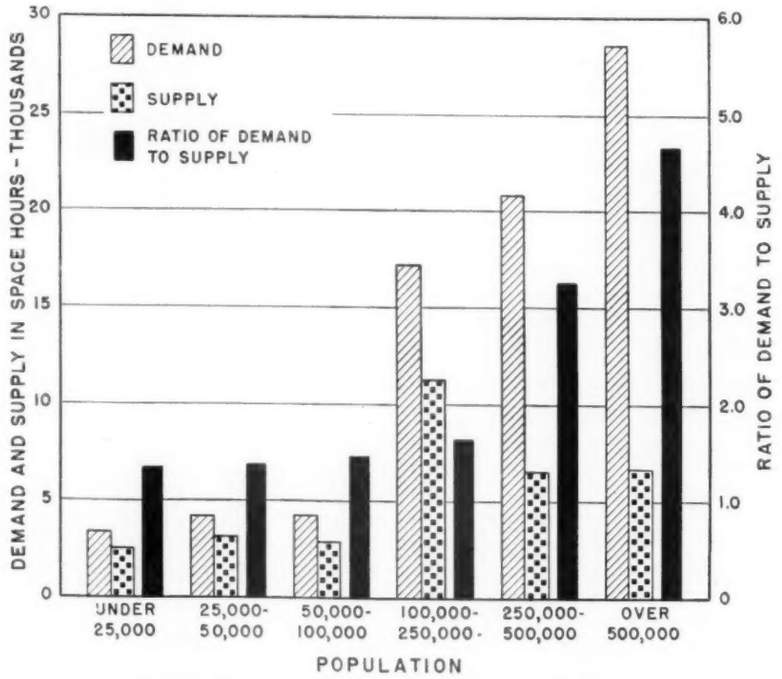

Figure 2.—Demand for and supply of parking space in the core area of the central business district, in terms of space hours.

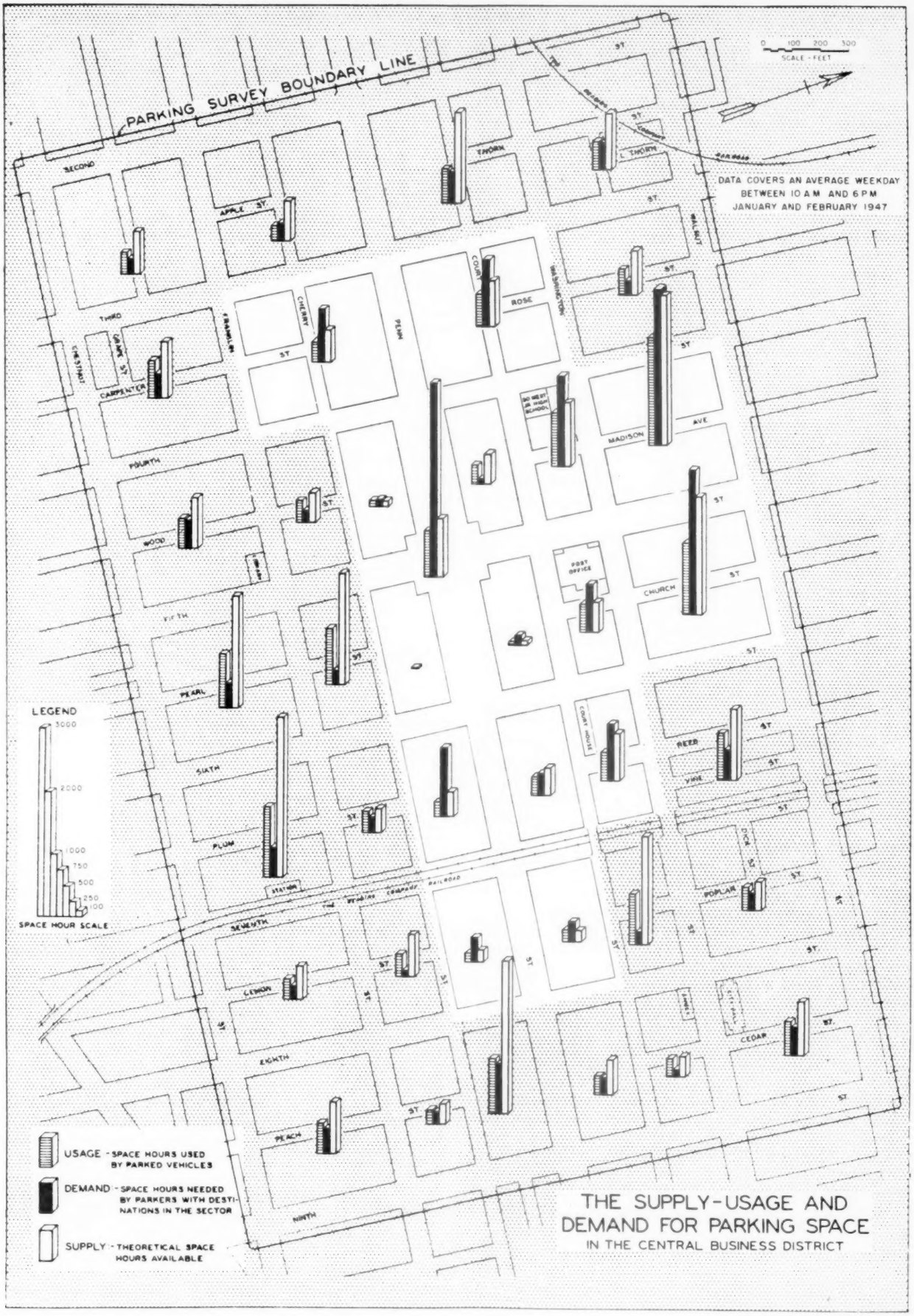

Figure 3.—The needs for additional terminal facilities are pinpointed on this map of supply, usage, and demand for parking space in the central business district of a typical city of 175,000 population.

Parking Space Supply and Demand

The parking studies, made under existing conditions, provide information only for those drivers who park in the central business district. It does not include the potential demand of those who might park there under different conditions.

For those having destinations in the central business district the demand for parking space shows a definite increase with the size of the city, as indicated in table 5. On a per capita basis, however, the central business districts in the smaller cities are greater parking generators than those in the larger cities, for reasons previously stated.

For the central business district as a whole, the supply of spaces is usually found to be at least equal to the demand since, for study purposes, the limits are so selected as to include the parking of nearly all drivers bound for the district. Some of the central blocks in the district, however, create a demand exceeding the supply in the same blocks. Table 5 and figure 2 indicate that the volume of demand for spaces in this core area increases in the larger cities whereas the supply, although increasing in cities of medium size, drops off in the larger cities where high land values in the core tend to preclude the use of space for parking purposes.

Figure 3 illustrates the relation of parking-space supply, usage, and demand in a typical city of about 175,000 population. Scaled bars show, for each block, the parking space available, the usage of that space, and the demand expressed for parking space in that block. The use of space-hour units permits direct comparisons. The unshaded central portion of the map shows the core area of the central business district, and covers those blocks in which the demand for space exceeds the supply. The map thus graphically pinpoints areas deficient in parking space.

Traffic and Travel Habits

As cities increase in population, the total 8-hour inbound volume of traffic, the average hourly volume in and out, and the peak volume in and out of the central business district increase, as shown in table 6. But when the population of the city is considered, the central business districts of the smaller cities are bigger traffic generators per 1,000 population than are the larger cities. This, no doubt, is due largely to factors previously mentioned and to the fact that in the smaller cities the principal through routes pass through the downtown area with few or no alternates available.

Regardless of the size of the city, the ratio of peak-hour traffic to average hourly traffic in the 8-hour period is practically constant. Peak-hour volumes are about one-third again as large as the volumes during the average hour of the survey period.

The proportion "passing through" the central business district may more correctly be described as those who do not stop to park. It includes whatever "cruisers" there may be and, additionally, those cars in service stations or in garages being serviced or repaired. These data, in the last two columns of table 6, refer to vehicles entering the central business district and not to vehicles leaving or to number of trips. There does not seem to be much difference in the proportion of traffic passing through the central business district during the business day (10 a. m. to 6 p. m.) in cities of different population groups.

The proportion of traffic entering the central business districts in the peak half-hour of traffic movement (usually between 5 and 6 p. m.), which does not stop to park, increases as the size of the city increases. The development of employment centers in sections of the city other than the central business district creates a large movement of population twice a day going to and coming from work. Much of this movement is across town and through the district.

Figure 4 shows the volume of traffic entering and leaving the central business district, and the hourly accumulation of parked vehicles and of all vehicles in the central business district, in a typical city of 175,000 population. The bars for each street around the periphery of the cordon show the total 8-hour volume of traffic entering and leaving the central business district, segregated by type of vehicle and by direction as indicated in the legend for street traffic at the left.

The bar chart within the cordon line in figure 4 shows the hourly total inbound and outbound traffic volumes, the shaded lower portions of the bars indicating the proportion of inbound traffic that entered the central business district and parked, and the proportion of outbound traffic coming from parking spaces. Plotted across the bar chart are curves showing the accumulation of traffic and of parking.

The difference between the volume of inbound traffic and outbound traffic for each hour period, when cumulated, represents the number of vehicles remaining in the business district at any hour period. When allowance is made for the number of vehicles parked, the number moving on the streets at the beginning of the study period, and the number of parkers with origins within the district, it is possible to estimate the actual volume of inbound traffic which may be considered as potential users of an alternate route.

Continued periodic cordon counts are desirable, after the completion of a study, to detect changing trends in traffic movements and in the accumulation of vehicles in the downtown area, the latter being an indication of the demand for parking space. By repeating the cordon count, the value of the basic parking study can be extended over a longer period of time.

Table 7.—*Length of time parked and distance walked to destination*

Population group	Number of cities	Percentage parked—		Percentage walking—	
		Less than 30 minutes	4 hours and over	Less than 400 feet	800 feet and over
Under 25,000	9	56	8	70	9
25,000–50,000	4	52	10	78	5
50,000–100,000	2	52	10	77	7
100,000–250,000	8	43	15	64	14
250,000–500,000	2	34	20	63	19
Over 500,000	2	[1] 28	25	46	30

[1] Estimated from different groupings of length of time parked.

Length of Time Parked

Data have hitherto been available from many individual studies concerning the habits of parkers as to duration of parking and the distances walked after parking, but this is the first time it has been possible to assemble the results of studies made under the same procedures in cities of various population groups.

The proportion of cars parked less than 30 minutes in the largest cities is only half of those parked for the same length of time in the smallest cities, as shown in table 7. The proportion parked 4 hours and over, however, is three times as large. An influence here is the practice, more common in smaller cities, of using the car to drive home or elsewhere at noon for lunch.

Walking Distances

Definite trends are also apparent, from table 7, in the distances people walk to their destinations after parking their cars. The lengths of blocks vary but, generally speaking,

Table 6.—*Traffic volumes and ratios in the central business district*

Population group	Number of cities	Average 8-hour volume, inbound [1]	Average hour volume, in and out	Peak half-hour volume, in and out [2]	Ratio of peak to average hour, in and out	In-and-out volume per 1,000 population, peak half-hour	Percentage of vehicles passing through [3] in—	
							8 hours	Peak half-hour
Under 25,000	9	13,000	3,300	2,500	1.34	139	52	59
25,000–50,000	4	21,000	5,300	3,600	1.35	107	61	70
50,000–100,000	2	26,000	6,600	4,420	1.34	61	52	69
100,000–250,000	7	41,000	11,000	6,810	1.33	41	60	70
250,000–500,000	3	54,000	13,700	9,110	1.33	25	60	75
Over 500,000	2	69,000	17,600	12,000	1.34	14	58	91

[1] 8-hour period, 10 a. m. to 6 p. m.; all vehicles.
[2] Peak half-hour for traffic movement, generally between 5 and 6 p. m.
[3] Percentage of vehicles entering the central business district.

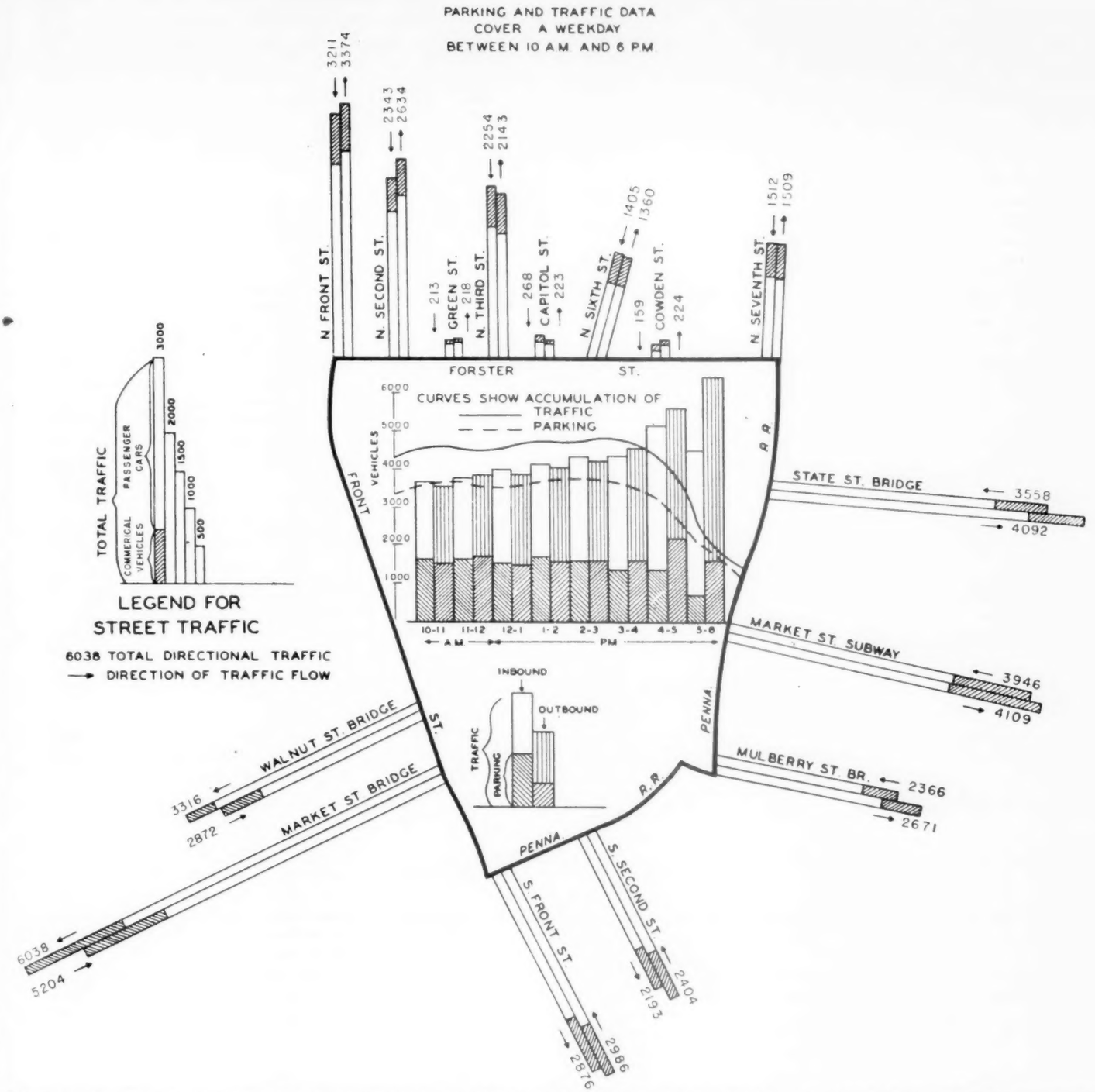

Figure 4.—Traffic entering or leaving the central business district and vehicles parking in that area, in a typical city of 175,000 population.

one block may be considered to be about 400 feet long. In small cities almost three-fourths of the people parking in the central business district park within one block of their destination. This proportion decreases to less than 50 percent in the largest cities.

The proportion walking more than 800 feet (two blocks) is relatively small in the smaller cities—less than 10 percent. In the largest cities, however, as many as 30 percent of the parkers walk more than 800 feet. These data may be useful, in a general way, in estimating the seriousness of the parking problem in other cities where extensive studies have not been made.

Trip Purposes

In any study in which an interview must be completed in less than a minute, it is extremely difficult to define trip purposes so definitely that they will be uniformly understood and applied. The results obtained, however, show definite trends for the average length of time parked for each of the more common trip purposes, as illustrated in table 8. Regardless of purpose, the average length of time parked increases in the larger cities as compared with the smaller cities. There does not appear to be much difference in the length of time parked by shoppers and by those on business trips. In both instances, the time parked increases with the size of the city.

"Other" purposes include trips for meals, and to doctors, dentists, movies, and social and other recreational activities. There does not seem to be much difference in the length of time parked for these purposes in cities of different sizes.

Effect of Parking Meters

The comprehensive type of parking study, wherein the type of parking and times of arrival and departure are noted, permits special types of analyses to be made—among

these being observation of the extent of violation of parking-time restrictions shown in table 9.

All of the 25 cities for which pertinent data are available have one or more zones in the central business district with time restrictions but without parking meters, and 13 of them have metered zones. In table 9, the first group reported includes some cities in which there were no meters, some cities where there were no unmetered curbs, and some having both metered and unmetered curbs. It is, therefore, only a general comparison between the two types of zones.

To present data on a more nearly comparable basis, an analysis is shown in table 9 for a second group of cities, comprising only those where data were available in the same city and in the same time-restriction class for both metered and unmetered but restricted spaces.

Data from each of 11 cities, where curb parking was observed in both types of zones, indicate that violations in metered zones were considerably less, both as to the numbers of violators and as to their use of time. This is also true when the data are segregated in time-restriction groups. It is also apparent that, in general, the proportion of overtime parkers and of overtime usage decreases as the length of time restrictions increases.

It is probable that the data from these several cities are not strictly comparable because of differences in enforcement policies. On the other hand, all data were obtained from studies limited to the central business districts, where there was little difference in opportunity for enforcement. As the occasion presents itself, studies should be made before and after meters are installed to obtain as fair a comparison as possible of the violation of parking restrictions.

Table 8.—*Average length of time parked for each purpose of trip*

Population group	Number of cities	Average time parked for each trip purpose, in hours				
		Work	Shopping	Business	Other	All purposes
Under 25,000	9	3.0	0.7	0.7	1.0	1.1
25,000–50,000	4	2.9	.7	.8	.9	1.3
50,000–100,000	2	3.3	.8	.7	.9	1.3
100,000–250,000	8	4.4	1.1	1.2	1.7	1.8
250,000–500,000	3	4.5	1.4	1.2	1.5	1.8
Over 500,000	2	5.1	1.4	1.4	1.2	2.5

Table 9.—*Comparison of overtime parking at metered curbs and at unmetered but restricted curbs, in the central business district*

Time zones	Number of cities	Percentage of overtime parking [1]		Percentage of space hours—			
				Used by violators [2]		Used in excess [3]	
		Unmetered	Metered	Unmetered	Metered	Unmetered	Metered
ALL CITIES REPORTING							
All	25	28.4		45.6		31.3	
All	13		21.9		47.4		27.3
CITIES WITH BOTH METERED AND UNMETERED SPACES							
All	11	37.6	24.3	58.0	50.4	40.2	28.1
15-minute	2	67.5	61.3	60.6	84.2	51.7	61.2
30-minute	2	57.6	33.3	87.2	62.0	71.2	39.1
60-minute	7	37.6	22.0	65.3	53.0	44.9	28.8
90-minute	1	33.8	18.6	65.0	53.6	42.9	30.4
2-hour	6	21.8	12.5	38.1	32.3	21.0	14.6

[1] Percentage of all curb parkers in zones indicated.
[2] Total usage, including legal.
[3] Overtime usage only.

STATE ROAD-USER AND PERSONAL-PROPERTY TAXES ON SELECTED MOTOR VEHICLES (*Continued from page 39.*)

It might have been desirable to have included in this study a heavy passenger car and several additional trucks and combinations. The purpose, however, was to explore the field in a general way, without attempting the exhaustive investigation and analysis that would have been required to cover every possible vehicle type and every possible tax.

The relatively low gross vehicle weight of the 40,000-pound tractor-semitrailer was chosen in order to have a vehicle that could be registered in any State; and had it not been for this factor a combination of 50,000 to 56,000 pounds, in general use in many States, might have been included.

A diesel-powered vehicle of 70,000 to 75,000 pounds gross vehicle weight might also have been represented but the differences between gasoline and diesel vehicles in fuel consumption, fuel- and vehicle-tax schedules, etc., make comparisons difficult; and the very heavy diesel units, common throughout the West, exceed the maximum size and weight limits of most of the other States. Furthermore, the diesels now in use are engaged primarily in interstate operation and this study was limited to intrastate vehicles. The use of diesel power in heavy vehicles, however, has already become sufficiently important to warrant special study of existing road-user taxes with respect to their application to diesel vehicles.

THE IDENTIFICATION OF ROCK TYPES (*Continued from page 47.*)

amphibolites contain plagioclase feldspar instead of quartz. This distinction may be impossible to make in the hand specimen.

Difficulties with Intrusive Igneous Rocks

In trials of this method by selected groups of students, more difficulty was found in identification of the intrusive type of igneous rocks than any other general group. The difficulty may have been due to too much emphasis on the feldspar content of the rock, and too little regarding the other essential constituents. A study of figure 1 will show that of the coarse-grained igneous rocks, granite is the only kind which contains an appreciable amount of quartz, and that gabbro contains the greatest amount of the dark ferromagnesian minerals (mica, hornblende, and augite) with diorite containing the next greatest amount. Consequently, if the rock is hard, with visible, interlocking grains of approximately the same size, and contains an appreciable amount of quartz, it probably is a granite. On the other hand, if the rock has the same characteristics as given above, but contains little if any quartz, it can be named by reference to the ferromagnesian mineral content as indicated by the color of the rock. A rock of light color may be a syenite, one of medium color a diorite, and one of dark color a gabbro.

Attention should be given to the transition of rock by insensible stages from one kind to another. Granites will grade into syenites, and syenites into diorites, for instance; or a coarse-grained rock will grade into a fine-grained rock of the same mineralogical composition. Two samples of rock from the same deposit may be sufficiently different to warrant different names. Consequently, the identification of the hand specimen by the method given here does have some limitations. However, a careful study of the sample, following the method outlined, should permit the user to name the rock with a relatively small margin of error.

State Road-User and Personal-Property Taxes on Selected Motor Vehicles, 1950

BY THE RESEARCH REPORTS BRANCH
BUREAU OF PUBLIC ROADS

Reported by R. W. MEADOWS and S. F. BIELAK, Highway Economists

The extensive need for highway improvement with which the nation is faced has raised to vital importance the study of existing and prospective sources of highway revenue. Road-user imposts—registration fees and gasoline taxes—supply a major part of the current income for highways. But in considering the levies paid on motor vehicles, direct property taxes must also be taken into account. Although not collected as highway revenue, these property taxes are in many States assessed in sizable amount and in such different fashion from taxes on other forms of property as to make them particular levies on motor vehicles.

In this report there are presented data on the registration and other fees, gasoline taxes, and direct property taxes that would be collected for each of seven representative types of vehicles in each of the States during 1950. In addition, data are reported separately for some of the commercial vehicles according to their use in private operation, farm service, or contract hauling. Comparisons can thus be made of the taxes paid for similar vehicles in different States, for different types of vehicles in the same State, or for the same vehicle in different types of service.

The ranges discovered among the States are extensive. For instance, the registration fee for a three-axle combination in private use varies from $45 to $577, and the property tax from $35 to $235. The total taxes on a single-unit van in contract service range from $135 to $746. The average for all States of road-user plus property taxes for a light passenger car is $55; for a five-axle combination in contract service it is $2,400. For a single-unit stake truck, the average of total taxes is $69 for farm service, $132 for private use, and $217 for contract carriage.

THIS study presents a comparison of the State road-user taxes and all direct property taxes that would be paid on a group of typical motor vehicles in one year. It is intended primarily to show the road-user taxes on a specific group of vehicles and to provide comparisons between the taxes paid on (1) different vehicles in a given State, (2) similar vehicles in different States and regions, (3) similar vehicles in different types of service in the same State, and (4) similar vehicles in different types of service in different States and regions. The information presented makes it possible to study the principal road-user taxes as a group, in preference to considering each separately as has frequently been necessary in the past. All of the taxes and fees given are for a full year, based on tax rates in effect January 1, 1950.

The Typical Vehicles

Seven vehicles and combinations, representing a cross section of the vehicle population, were selected for inclusion in the study—one light-weight passenger car, one medium-weight passenger car, three single-unit trucks, and two tractor-semitrailer combinations. The single-unit trucks include a half-ton pickup, a 1½-ton stake truck, and a 2½-ton van. Of the two tractor-semitrailer units, one is a three-axle combination of 40,000 pounds gross vehicle weight, chosen so that it would fall within the maximum length and weight limits of all of the States. The other combination is a five-axle tractor-semitrailer of 64,000 pounds gross vehicle weight (indicative of heavy operation) which would be permitted to register in 24 States.

In order to obtain the tax data on a uniform basis in all of the States, a detailed outline of the specifications of each of the selected vehicles was submitted to the State authorities in November 1949, for determination of the exact fees and taxes. Table 1 gives these specifications, together with the assumed annual mileage traveled, motor fuel consumed, and other factors needed to compute the various taxes. It was also specified that the vehicles were in intrastate operation, and that they had been operated in the same State since purchased new in 1948. This avoided the complex situations that would have been encountered in computing taxes on vehicles in interstate operation, and eliminated consideration of the sales taxes (or their counterparts) on new vehicles that are in effect in most States. The relative sizes of the seven typical vehicles are represented on this page (only one passenger car is shown since the two vehicles in this category are very nearly the same length).

Types of Service

Distinctly different tax rates are in effect in most States for commercial vehicles operated privately (not for hire), as contract carriers (for hire), and in farm service. Information was therefore obtained, and was tabulated separately, for each of these three types of operation, where applicable, for each vehicle studied.

Vehicles in private operation are those used solely for carrying goods owned or sold by the vehicle owner, with no direct transportation charge. Contract carriers are employed in hauling goods for others, with a direct transportation charge, at times and to destinations according to the jobs for which they are hired. Operation of contract carriers is usually subject to State franchise and regulation. Common carriers, which operate for hire over established routes and on fixed schedules, are not included in the study because of their more complex tax schedules and forms of regulation, and the fact that their operation is frequently interstate.

The farm service classification represents a reduced registration fee for farmers' trucks, but without restriction as to the highways they may use. This arrangement is in effect in 23 States. (The nominal charge imposed as the sole registration fee by some States for farm vehicles licensed for restricted operation on or in the immediate vicinity of the farm is not included in this study.)

Table 1.—*Outline of data used in computing State road-user taxes and property taxes on selected vehicles, 1950 registration year*

Factors affecting taxation	Vehicle description and use (vehicle purchased new in 1948)								
	Passenger car		Single-unit truck			Three-axle tractor-semitrailer combination		Five-axle tractor-semitrailer combination	
	Light two-door sedan	Medium four-door sedan	Pick-up	Stake	Van	Tractor-truck	Semi-trailer, 28-foot van	Tractor-truck	Semi-trailer, 34-foot van
Price, f. o. b. factory	$1,307	$2,087	$1,164	$1,610	$4,450	$5,000	$3,265	$15,400	$5,900
Horsepower:									
S. A. E.	25.35	30.63	32.5	29.4	33.75	36.0	------	72.6	------
Brake	95.0	115.0	100.0	90.0	111.5	110.0	------	245.0	------
Weight:									
Manufacturer's rated capacity—tons	------	------	½	1½	2½	2	------	------	------
Chassis weight—pounds	------	------	------	4,180	5,700	------	------	------	------
Empty weight—do	2,995	3,855	3,061	5,140	7,900	8,000	7,500	19,000	8,900
Load capacity—do	------	------	1,640	7,360	10,600	14,000	10,500	17,000	19,100
Gross vehicle weight—do	3,895	4,755	4,700	12,500	18,500	22,000	18,000	36,000	28,000
Gross weight of combination—pounds	------	------	------	------	------	40,000	------	64,000	------
Length:									
Wheelbase—inches	------	------	114	161	172	136	------	203	------
Distance between tandem axles—inches	------	------	------	------	------	------	------	48	48½
Length of combination—feet	------	------	------	------	------	39½	------	49½	------
Tires:									
Size	------	------	------	7.50×20	9.00×20	10.00×20	10.00×20	11.00×20	11.00×20
Arrangement	Single	Single	Single	Dual	Dual	Dual	Dual	Dual tandem	Dual tandem
Total annual mileage:									
Farm—miles	------	------	6,000	5,500	------	------	------	------	------
Not for hire—do	9,500	10,500	9,000	12,000	15,000	35,000	------	------	------
For hire: Contract carrier—miles	------	------	------	20,000	25,000	45,000	------	75,000	------
Average mileage per gallon:									
Farm	------	------	15.5	10.0	------	------	------	------	------
Not for hire	16.5	14.5	15.0	9.0	6.5	5.0	------	------	------
For hire: Contract carrier	------	------	------	9.0	6.5	5.0	------	3.0	------
Annual motor-fuel consumption:									
Farm—gallons	------	------	387	550	------	------	------	------	------
Not for hire—do	576	724	600	1,333	2,307	7,000	------	------	------
For hire: Contract carrier—gallons	------	------	------	2,222	3,846	9,000	------	25,000	------
Total revenue ton-miles (avg. load)	------	------	------	40,400	73,000	303,300	------	744,750	------
Average gross weight—pounds	------	------	------	9,180	13,730	[1] 28,975	------	[1] 47,755	------
Gross annual earnings	------	------	------	$7,000	$10,000	$20,000	------	$40,000	------

[1] Gross weight of combination.

Property Taxes

In most cases the property taxes on motor vehicles have little or no relation to the use of highways and the revenues from them are not available for highways. They are so closely associated with registration fees in their relation to costs of operation, however, and comprise such a large portion of the total taxes paid on motor vehicles in some States that their inclusion in this study was necessary in order to obtain equitable comparisons. The registration fees for individual vehicles vary considerably among the States, and the property taxes in some instances greatly exceed the registration fees paid. When property taxes and registration fees are considered together, however, the differences among the States are proportionately smaller. It is worth noting that the valuation of motor vehicles for tax purposes is generally conceded to be much closer to market value than is the valuation of other personal property subject to the same taxes. It is also probable that motor vehicles constitute a very considerable portion of taxable personal property in many jurisdictions. While this study is not directly concerned with personal property taxes per se, it suggests an area of research that should not be neglected by those interested in the tax burdens on the motor-vehicle owner.

The property taxes that are given, for all except the farm vehicles, include all taxes levied by the State, county, city, or other local governmental unit in which the vehicle is domiciled, and are the taxes that would be imposed on the vehicle in the capital city of the State. The property taxes given for farm vehicles include State, county, and district or other property taxes that would be collected in an average rural agricultural community in the State. In a few States where uniform State-wide valuation and tax rates are in effect in all jurisdictions, there would be no difference between property taxes on farm vehicles and those registered in the capital city of the State. In two States—California and Washington—property taxes on motor vehicles have been replaced by "in lieu" taxes. These taxes have many of the characteristics of property taxes, but since neither the levies nor the distribution of their proceeds are directly related to the jurisdiction in which they were collected, they have been classified as road-user imposts. In both of these instances the State courts have ruled them not to be property taxes.

Carrier Taxes

In the consideration of motor-carrier taxes paid for vehicles in contract-carrier service, gross receipts taxes and other levies that are imposed on general business, and not limited to motor carriers, have been eliminated. Fees for authority to operate, and other fees paid only at the time a carrier begins to haul goods for hire, have also been excluded.

Care should be taken in comparing the carrier taxes of the several States. Many of the States have special registration classes for vehicles used in for-hire service. The fees in the special registration classes, in most cases, are substantially greater than the registration fees for vehicles in private (not-

Table 2.—*Average, low, and high road-user and property taxes on selected motor vehicles*

Vehicle and service	Average fee for all States					Lowest fee					Highest fee				
	Registration fee [1]	Gasoline tax	Total road-user taxes	Property tax	Total	Registration fee [1]	Gasoline tax	Total road-user taxes	Property tax	Total	Registration fee [1]	Gasoline tax	Total road-user taxes	Property tax	Total
Passenger car:															
Light-weight	$11.53	$29.33	$40.85	$24.07	$55.10	$2.50	$11.52	$20.28	$5.00	$27.78	$24.00	$51.84	$61.84	$41.62	$85.90
Medium-weight	14.90	36.86	51.77	34.36	72.11	3.00	14.48	25.48	8.00	35.37	39.00	65.16	81.18	62.76	114.20
Pick-up truck:															
Farm	13.09	19.71	32.80	14.76	41.23	2.50	7.74	17.74	5.00	20.48	37.00	34.83	54.42	35.10	64.69
Private	16.48	30.55	47.03	21.10	59.52	2.50	12.00	25.50	5.00	39.00	37.00	54.00	69.70	35.02	89.45
Stake truck:															
Farm	29.22	28.01	57.22	19.78	68.52	4.50	11.00	21.00	5.00	32.44	70.00	49.50	99.00	37.75	125.08
Private	48.07	67.89	115.95	27.55	132.26	10.00	26.67	56.67	14.49	73.11	132.50	120.00	185.83	48.42	208.42
Contract	87.46	113.15	200.61	27.55	216.91	15.00	44.44	74.44	14.49	90.88	342.50	200.00	498.05	48.42	498.05
Van truck:															
Private	93.62	117.47	211.09	68.32	251.53	25.00	46.14	86.14	18.50	104.64	272.50	207.63	364.78	233.50	505.41
Contract	152.32	195.83	348.15	68.32	388.59	32.00	76.92	116.92	18.50	135.42	476.50	346.14	745.72	233.50	745.72
Three-axle combination:															
Private	229.28	356.43	585.70	121.65	657.70	45.00	140.00	271.00	34.94	327.94	577.00	630.00	997.00	234.56	1,043.25
Contract	373.50	458.27	831.76	121.65	903.76	66.00	180.00	333.00	34.94	367.94	892.00	810.00	1,441.00	234.56	1,441.00
Five-axle combination:															
Contract	920.65	1,322.91	2,243.56	289.53	2,400.40	217.00	750.00	1,217.00	59.38	1,398.75	2,186.50	2,250.00	3,936.50	521.34	3,936.50

[1] Includes the carrier taxes and "other taxes and fees" shown in tables 3-8.

Table 3.—*Road-user and personal-property taxes on selected passenger vehicles*

Region and State	Light two-door sedan							Medium four-door sedan						
						Rank of State							Rank of State	
	Registration fee	Property tax	Other taxes and fees	Gasoline tax	Total	Total fees and taxes	Total, excluding property tax	Registration fee	Property tax	Other taxes and fees	Gasoline tax	Total	Total fees and taxes	Total, excluding property tax
New England:														
Maine	$14.00	$16.34	-----	$34.56	$64.90	14	10	$16.00	$26.09	-----	$43.44	$85.53	13	14
New Hampshire	13.65	11.76	-----	23.04	48.45	29	34	21.60	18.78	-----	28.96	69.34	27	26
Vermont	22.00	-----	-----	28.80	50.80	28	7	22.00	-----	-----	36.20	58.20	37	16
Massachusetts	3.00	23.09	-----	17.28	43.37	38	49	4.50	36.86	-----	21.72	63.08	30	48
Rhode Island	12.00	26.60	-----	23.04	61.64	17	35	16.00	33.60	-----	28.96	78.56	17	36
Connecticut	7.00	36.37	-----	23.04	66.41	11	41	9.00	47.99	-----	28.96	85.95	12	41
Middle Atlantic:														
New York	15.00	------	-----	23.04	38.04	44	32	20.50	------	-----	28.96	49.46	42	28
New Jersey	10.00	------	$1.00	17.28	28.28	48	44	15.50	------	$1.00	21.72	38.22	48	40
Pennsylvania	10.00	------	-----	28.80	38.80	43	30	10.00	------	-----	36.20	46.20	45	34
Delaware	8.00	------	-----	28.80	36.80	46	33	12.00	------	-----	36.20	48.20	44	32
Maryland	10.00	5.00	-----	28.80	43.80	36	29	15.00	8.00	-----	36.20	59.20	35	25
District of Columbia	5.00	18.00	1.00	23.04	47.04	32	42	8.00	25.00	1.00	28.96	62.96	31	42
West Virginia	17.00	32.65	-----	28.80	78.45	5	16	22.40	52.15	-----	36.20	110.75	2	15
Southeastern:														
Virginia	9.00	22.00	-----	34.56	65.56	13	21	11.70	28.60	-----	43.44	83.74	14	21
North Carolina	10.00	19.79	-----	40.32	70.11	10	9	12.00	32.68	-----	50.68	95.36	7	9
South Carolina	3.00	25.80	1.00	34.56	64.36	15	31	4.00	39.12	1.00	43.44	87.56	11	30
Georgia	2.50	28.48	-----	40.32	71.30	9	22	4.50	39.61	-----	50.68	94.79	8	20
Florida	15.00	------	.25	40.32	55.57	24	4	20.00	------	.25	60.68	70.93	26	5
Kentucky	4.50	36.19	.50	40.32	81.51	3	18	4.50	54.75	.50	60.68	110.43	3	19
Tennessee	7.50	------	.50	40.32	48.32	30	11	10.00	------	.50	50.68	61.18	33	12
Alabama	13.00	18.09	.50	34.56	66.15	12	12	18.00	21.44	.50	43.44	83.38	15	11
Mississippi	10.22	41.12	-----	34.56	85.90	1	19	12.70	51.20	-----	43.44	107.34	5	18
East Central:														
Ohio	10.00	------	-----	23.04	33.04	47	38	10.00	------	-----	28.96	38.96	47	39
Indiana	11.00	27.18	-----	23.04	61.22	18	37	12.00	36.17	-----	28.96	77.13	20	37
Illinois	10.50	15.01	-----	17.28	42.79	39	47	10.50	19.05	-----	21.72	51.27	40	47
Michigan	10.50	------	-----	17.28	27.78	49	46	13.65	------	-----	21.72	35.37	49	44
Wisconsin	16.00	------	-----	23.04	39.04	42	27	16.00	------	-----	28.96	44.96	46	35
Minnesota	23.20	------	-----	28.80	52.00	26	6	39.00	------	-----	36.20	75.20	22	3
Iowa	24.00	------	-----	23.04	47.04	33	15	33.00	------	-----	28.96	61.96	32	10
Missouri	11.00	15.41	-----	11.52	37.93	45	48	11.00	24.66	-----	14.48	50.14	41	49
Southwestern:														
Arkansas	13.00	21.88	-----	37.44	72.32	8	8	18.00	28.30	-----	47.06	93.36	10	7
Louisiana	3.00	22.62	-----	51.84	77.46	6	5	3.00	28.28	-----	65.16	96.44	6	6
Oklahoma	23.90	------	.50	37.44	61.84	16	1	33.62	------	.50	47.06	81.18	16	1
Texas	11.16	21.36	-----	23.04	55.56	25	36	19.20	26.82	-----	28.96	74.98	24	33
West Central:														
North Dakota	22.50	------	-----	23.04	45.54	34	17	30.75	------	-----	28.96	59.71	34	13
South Dakota	17.00	------	-----	23.04	40.04	40	25	25.00	------	-----	28.96	53.96	38	22
Nebraska	8.00	39.25	-----	34.56	81.81	2	23	8.00	62.76	-----	43.44	114.20	1	24
Kansas	10.00	41.62	-----	28.80	80.42	4	28	13.15	59.12	-----	36.20	108.47	4	29
Mountain:														
Montana	13.00	25.80	-----	34.56	73.36	7	14	13.00	37.04	-----	43.44	93.48	9	17
Idaho	5.00	------	-----	34.56	39.56	41	26	5.00	------	-----	43.44	48.44	43	31
Wyoming	5.00	15.68	-----	23.04	43.72	37	45	5.00	25.04	-----	28.96	59.00	36	46
Colorado	5.60	15.68	-----	34.56	55.84	23	24	6.95	25.04	-----	43.44	75.43	21	27
New Mexico	18.00	------	-----	40.32	58.32	20	2	27.00	------	-----	50.68	77.68	18	2
Arizona	3.50	18.60	-----	28.80	50.90	27	39	3.50	28.20	-----	36.20	67.90	28	38
Utah	5.00	30.12	.50	23.04	58.66	19	43	5.00	42.72	.50	28.96	77.18	19	45
Nevada	5.00	26.50	-----	25.92	57.42	22	40	5.00	37.50	-----	32.58	75.08	23	43
Pacific:														
Washington	5.00	------	15.75	37.44	58.19	21	3	5.00	------	22.25	47.06	74.31	25	4
Oregon	10.00	------	-----	34.56	44.56	35	20	10.00	------	-----	43.44	53.44	39	23
California	6.00	------	16.00	25.92	47.92	31	13	6.00	------	25.00	32.58	63.58	29	8

for-hire) service. The difference, while technically classed as part of the registration fee, is in reality a special carrier fee. There is, of course, the compensating factor that vehicles in carrier service usually can be expected to operate a considerably greater mileage than those not for hire, thus reducing the per-mile cost of their registration fees.

The majority of trucks are used for the ordinary private service of carrying goods owned or sold by the vehicle owner, and for which there is no direct transportation charge. Even these trucks, however, are subject to mileage or other carrier taxes under some conditions, and the variations in the tax structures of the States made it necessary in a few instances to make arbitrary decisions on the inclusion or exclusion of these special levies. The general policy followed was to include only the taxes that would have to be paid on almost all of the vehicles in a given group. For example, the laws of some States are so written that practically all vehicles of more than 1½ tons (manufacturer's rated capacity) would have to pay certain mileage or compensatory taxes, whether in private or for-hire operation. In the same States many vehicles of 1½-ton capacity or less would not be subject to the tax. In such a case the tax has been shown only for the heavier vehicles. It should be remembered that the purpose of this study is to present a comparison of tax rates and burdens on certain typical vehicles rather than to include all taxes on all vehicles. Undoubtedly many of the larger trucks traveling in interstate commerce are subject to greater taxes than are reported in this study, and are also subject to restrictions and regulations that impose additional burdens. The larger units apparently have certain offsetting economic advantages, however, or they would not be in use.

Data Collected From States

The data received from the States are presented in tables 3–8. Table 3 reports the taxes on the light- and medium-weight passenger cars. Table 4 shows the taxes on pick-up trucks in farm service and in private use: these light trucks are almost never registered for contract-carrier service. Table 5 covers the taxes on the single-unit stake truck, operated as a farm vehicle and in both private and for-hire hauling. Tables 6 and 7 report respectively the taxes on the single-unit van and the three-axle, 40,000-pound tractor-semitrailer, in private and in contract-carrier service. These two types are seldom used on farms. Table 8 shows the taxes on the five-axle, 64,000-pound tractor-semitrailer operated as a contract carrier. Such large vehicles are rarely found in private or farm service.

In addition to the tabular presentation, the variations among States of the registration fees, gasoline taxes, and personal-property taxes, and their totals, are shown graphically in figures 1–6 (pp. 41–3) for some of the vehicles. Figures 1 and 2 represent average combined data for the two passenger cars; figures 3 and 4, for the single-unit, 1½-ton stake truck in private use; and figures 5 and 6, for the three-axle, 40,000-pound tractor-semitrailer in private use. In all six of these charts the States are arranged in order from lowest to highest costs, the rank in figures 1, 3, and 5 being according to total amount while in figures 2, 4, and 6 the rank is according to road-user taxes only.

Variations in Taxes

Figure 1 shows that for passenger cars the total road-user and personal-property taxes

Table 4.—*Road-user and personal-property taxes on a single-unit pick-up truck, 4,700 pounds gross vehicle weight*

Region and State	Farm							Private						
	Registration fee	Property tax	Other taxes and fees	Gasoline tax	Total	Rank of State: Total fees and taxes	Rank of State: Total, excluding property tax	Registration fee	Property tax	Other taxes and fees	Gasoline tax	Total	Rank of State: Total fees and taxes	Rank of State: Total, excluding property tax
New England:														
Maine	$15.00	$14.55	-----	$23.22	$52.77	5	11	$15.00	$14.55	-----	$36.00	$65.55	14	16
New Hampshire	21.15	10.48	-----	15.48	47.11	15	15	21.15	10.48	-----	24.00	55.63	31	26
Vermont	22.00	-----	-----	19.35	41.35	25	5	22.00	-----	-----	30.00	52.00	34	13
Massachusetts	7.50	20.56	-----	11.61	39.67	28	48	7.50	20.56	-----	18.00	46.06	40	49
Rhode Island	24.80	15.14	-----	15.48	55.42	3	7	18.00	21.20	-----	24.00	63.20	19	37
Connecticut	11.70	18.16	-----	15.48	45.34	19	38	11.70	25.05	-----	24.00	60.75	21	43
Middle Atlantic:														
New York	24.80	-----	-----	15.48	40.28	27	8	24.80	-----	-----	24.00	48.80	37	20
New Jersey	12.00	-----	$1.00	11.61	24.61	47	41	24.00	-----	$1.00	18.00	43.00	45	33
Pennsylvania	16.50	-----	-----	19.35	35.85	35	18	16.50	-----	-----	30.00	46.50	39	22
Delaware	10.00	-----	-----	19.35	29.35	44	34	15.00	-----	-----	30.00	45.00	42	29
Maryland	12.00	5.00	-----	19.35	36.35	34	27	12.00	5.00	-----	30.00	47.00	38	38
District of Columbia	20.00	14.66	1.00	15.48	51.14	6	16	20.00	14.66	1.00	24.00	59.66	22	27
West Virginia	15.00	23.28	-----	19.35	57.63	2	22	15.00	29.10	-----	30.00	74.10	7	28
Southeastern:														
Virginia	12.00	15.40	-----	23.22	50.62	7	20	12.00	15.40	-----	36.00	63.40	18	21
North Carolina	10.00	7.19	-----	27.09	44.28	21	14	20.00	16.26	-----	42.00	78.26	6	6
South Carolina	5.00	15.51	1.00	23.22	44.73	20	35	5.00	28.38	1.00	36.00	70.38	10	36
Georgia	2.50	35.10	-----	27.09	64.69	1	33	2.50	34.71	-----	42.00	79.21	5	30
Florida	23.25	-----	.25	27.09	50.59	8	2	23.25	-----	.25	42.00	65.50	15	2
Kentucky	4.50	16.00	.50	27.09	48.09	11	26	10.00	30.00	.50	42.00	82.50	3	12
Tennessee	7.50	-----	.50	27.09	35.09	37	21	15.00	-----	.50	42.00	57.50	29	10
Alabama	15.00	11.34	.75	23.22	50.31	10	10	15.00	18.09	.75	36.00	69.84	11	14
Mississippi	7.00	13.99	-----	23.22	44.21	22	32	10.00	34.69	-----	36.00	80.69	4	24
East Central:														
Ohio	15.70	-----	-----	15.48	31.18	42	29	26.50	-----	-----	24.00	50.50	35	18
Indiana	15.00	15.54	-----	15.48	46.02	16	31	15.00	19.15	-----	24.00	58.15	26	41
Illinois	12.00	9.77	-----	11.61	33.38	40	42	12.00	13.24	-----	18.00	43.24	44	46
Michigan	10.85	-----	-----	11.61	22.46	48	44	24.80	-----	-----	18.00	42.80	47	35
Wisconsin	5.00	-----	-----	15.48	20.48	49	47	20.00	-----	-----	24.00	44.00	43	32
Minnesota	20.00	-----	-----	19.35	39.35	29	9	25.00	-----	-----	30.00	55.00	33	11
Iowa	25.00	-----	-----	15.48	40.48	26	6	25.00	-----	-----	24.00	49.00	36	19
Missouri	10.00	10.72	-----	7.74	28.46	45	49	15.00	15.41	-----	12.00	42.41	48	48
Southwestern:														
Arkansas	12.00	10.34	-----	25.16	47.50	13	13	12.00	14.68	-----	39.00	65.68	13	17
Louisiana	3.00	-----	-----	34.83	37.83	31	12	10.00	25.45	-----	54.00	89.45	1	4
Oklahoma	9.60	-----	.50	25.16	35.26	36	19	20.00	-----	.50	39.00	59.50	23	7
Texas	9.40	7.06	-----	15.48	31.94	41	40	18.80	16.69	-----	24.00	59.49	24	34
West Central:														
North Dakota	21.00	-----	-----	15.48	36.48	33	17	34.00	-----	-----	24.00	58.00	27	8
South Dakota	15.00	-----	-----	15.48	30.48	43	30	15.00	-----	-----	24.00	39.00	49	40
Nebraska	8.00	16.07	-----	23.22	47.29	14	28	15.00	35.02	-----	36.00	86.02	2	15
Kansas	7.50	20.95	-----	19.35	47.80	12	39	7.50	33.03	-----	30.00	70.53	9	42
Mountain:														
Montana	10.00	12.43	-----	23.22	45.65	18	25	10.00	25.80	-----	36.00	71.80	8	23
Idaho	5.00	-----	-----	23.22	28.22	46	37	10.00	-----	-----	36.00	46.00	41	25
Wyoming	5.00	13.96	-----	15.48	34.44	38	46	5.00	13.96	-----	24.00	42.96	46	47
Colorado	5.75	13.97	-----	23.22	42.94	24	36	5.75	13.97	-----	36.00	55.72	30	39
New Mexico	16.00	-----	-----	27.09	43.09	23	4	16.00	-----	-----	42.00	58.00	28	9
Arizona	14.35	16.80	-----	19.35	50.50	9	24	14.35	16.80	-----	30.00	61.15	20	31
Utah	7.50	14.73	.50	15.48	38.21	30	43	7.50	23.55	.50	24.00	55.55	32	45
Nevada	5.00	14.47	-----	17.42	36.89	32	45	5.00	27.00	-----	27.00	59.00	25	44
Pacific:														
Washington	10.50	-----	10.25	25.16	45.91	17	3	16.00	-----	10.25	39.00	65.25	16	3
Oregon	10.85	-----	-----	23.22	34.07	39	23	21.70	-----	12.00	36.00	69.70	12	1
California	16.00	-----	21.00	17.42	54.42	4	1	16.00	-----	21.00	27.00	64.00	17	5

vary widely. Peculiarly enough, the three States with the highest charges have registration fees that differ very little, and gasoline taxes that are only about 50 percent larger, than the three States with the lowest totals. Property taxes alone in the three highest States exceed the sum of the registration fees and gasoline taxes in the three lowest States, which have no property taxes. It will be noted generally that the States with very low registration fees have compensatingly large property taxes, while the States with high registration fees have no property taxes at all. A similar but less striking situation exists for trucks and combinations, as evidenced in figures 3 and 5.

On the other hand, it may be seen from figure 2 that, of the five States with gasoline-tax rates of 3 cents or less, Massachusetts, Missouri, and Illinois have the lowest road-user revenue per passenger car of all the States, while Michigan and New Jersey fare little better. The latter two States, collecting no personal property taxes, are the lowest in figure 1. The effect of the low gasoline-tax rates is similarly evident for trucks and combinations in figures 3–6.

Extremes and Averages

The road-user and personal-property taxes listed in detail for all States in tables 3–8 are summarized in table 2 (page 34) to show the nation-wide average fees for each of the vehicles selected, together with the lowest and highest fees for each vehicle and type of service. The average fees are simple unweighted arithmetic averages of the totals for all States. In the case of property taxes they are averages reflecting only the States that levy such a tax.

In making comparisons between national averages and the fees of a given State, or between fees for different vehicle types within the same or other States, adequate allowance should be made for the fact that some of the States with relatively high taxes on specific vehicles, or on vehicles in certain types of service, have a very small number of vehicles registered in that group.

Truck Registration Fees

The variations in truck registration fees among States, as shown in tables 4–8, are of considerable interest. In some States the tax schedules range from relatively low fees on light trucks to relatively high fees on heavy trucks (when compared with the fee ranges in other States), while in others this is reversed. The Mississippi registration fee for the pick-up truck, for example, ranked 38th among the States, but the fees for the heavier trucks in private service were 28th, 20th, and 9th, respectively, reflecting relatively more favorable fees for light trucks and less favorable fees for heavy trucks, when compared with other States. New Jersey, on the other hand, collects the 7th highest fee on the pick-up truck, with the fees on the heavier vehicles ranking 13th, 18th, and 29th among the States, thus imposing relatively high fees on light trucks as compared with heavy trucks. (In both of these States, the heavy tractor-semitrailer is not included because it is illegal.)

Table 5.—*Road-user and personal-property taxes on a single-unit stake truck, 12,500 pounds gross vehicle weight*

Region and State	Farm							Private							Contract, for hire							
						Rank of State							Rank of State								Rank of State	
	Registration fee	Property tax	Other taxes and fees	Gasoline tax	Total	Total fees and taxes	Total, excluding property tax	Registration fee	Property tax	Other taxes and fees	Gasoline tax	Total	Total fees and taxes	Total, excluding property tax	Registration fee	Property tax	Other taxes and fees	Carrier taxes and fees	Gasoline tax	Total	Total fees and taxes	Total, excluding property tax
New England:																						
Maine	$60.00	$20.13	----	$33.00	$113.13	2	2	$60.00	$20.13	----	$80.00	$160.13	11	11	$60.00	$20.13	----	$5.00	$133.33	$218.46	21	24
New Hampshire	25.00	14.49	----	22.00	61.49	32	39	75.00	14.49	----	53.33	142.82	16	16	75.00	14.49	----	2.00	88.88	180.37	31	33
Vermont	25.00	------	----	27.50	52.50	41	31	106.25	------	----	66.67	172.92	7	4	106.25	------	----	------	111.11	217.36	22	18
Massachusetts	18.00	28.44	----	16.50	62.94	30	47	18.00	28.44	----	40.00	86.44	48	48	18.00	28.44	----	5.00	66.67	118.11	48	48
Rhode Island	39.00	20.94	----	22.00	81.94	12	14	39.00	29.32	----	53.33	121.65	26	36	39.00	29.32	----	5.00	88.88	162.20	38	41
Connecticut	37.50	25.11	----	22.00	84.61	7	17	37.50	31.71	----	53.33	122.54	25	41	37.50	31.71	----	5.00	88.88	163.09	37	42
Middle Atlantic:																						
New York	40.80	------	----	22.00	62.80	31	12	40.80	------	----	53.33	94.13	44	35	40.80	------	----	------	88.88	129.68	46	43
New Jersey	25.50	------	$1.00	16.50	43.00	46	43	51.00	------	$1.00	40.00	92.00	45	37	51.00	------	$1.00	------	66.67	118.67	47	45
Pennsylvania	45.00	------	----	27.50	72.50	19	7	45.00	------	----	66.67	111.67	38	25	45.00	------	----	10.00	111.11	166.11	35	32
Delaware	22.50	------	----	27.50	50.00	44	35	45.00	------	----	66.67	111.67	39	26	45.00	------	----	------	111.11	156.11	40	37
Maryland	10.00	5.00	----	27.50	42.50	47	45	35.00	15.00	----	66.67	116.67	33	30	35.00	15.00	----	------	111.11	161.11	39	39
Dist. of Columbia	35.00	19.82	1.00	22.00	77.82	16	20	35.00	19.82	1.00	53.33	109.15	41	43	35.00	19.82	1.00	------	88.88	144.70	44	44
West Virginia	25.00	32.20	----	27.50	84.70	6	29	25.00	40.25	----	66.67	131.92	21	38	50.00	40.25	----	13.50	111.11	214.86	23	29
Southeastern:																						
Virginia	19.50	22.00	----	33.00	74.50	17	30	19.50	22.00	----	80.00	121.50	27	32	19.50	22.00	----	70.00	133.33	244.83	14	14
North Carolina	30.00	9.99	----	38.50	78.49	15	10	60.00	22.60	----	93.31	175.91	6	8	120.00	22.60	----	------	155.55	298.15	8	6
South Carolina	65.00	26.08	1.00	33.00	125.08	1	1	65.00	47.72	1.00	80.00	193.72	3	9	65.00	47.72	1.00	60.00	133.33	307.05	5	8
Georgia	10.00	36.00	----	38.50	84.50	8	37	10.00	35.60	----	93.31	138.91	17	28	25.00	35.60	----	25.00	155.55	241.15	15	20
Florida	51.00	------	.25	38.50	89.75	4	4	51.00	------	.25	93.31	144.56	15	10	141.75	------	.25	200.50	155.55	498.05	1	1
Kentucky	4.50	21.10	.50	38.50	64.60	28	42	32.00	39.56	.50	93.31	165.37	8	17	32.00	39.56	.50	77.00	155.55	304.61	7	7
Tennessee	12.50	------	.50	38.50	51.50	42	32	25.00	------	.50	93.31	118.81	29	20	50.00	------	.50	12.50	155.55	218.55	20	16
Alabama	22.50	13.44	.75	33.00	69.69	23	24	22.50	21.44	.75	80.00	124.69	23	29	22.50	21.44	.75	101.00	133.33	279.02	9	9
Mississippi	21.40	9.33	----	33.00	63.73	29	26	37.00	34.13	----	80.00	151.13	13	21	73.00	34.13	----	7.00	133.33	247.46	13	19
East Central:																						
Ohio	32.80	------	----	22.00	54.80	39	25	61.00	------	----	53.33	114.33	36	24	61.00	------	----	20.00	88.88	169.88	33	30
Indiana	35.00	15.54	----	22.00	72.54	18	21	35.00	19.15	----	53.33	107.48	42	44	35.00	19.15	----	12.00	88.88	155.03	41	40
Illinois	50.00	16.60	----	16.50	83.10	10	11	50.00	22.52	----	40.00	112.52	37	42	50.00	22.52	----	------	66.67	139.19	45	46
Michigan	17.85	------	----	16.50	34.35	48	48	51.00	------	----	40.00	91.00	46	40	51.00	------	----	30.00	66.67	147.67	42	38
Wisconsin	27.50	------	----	22.00	49.50	45	36	110.00	------	----	53.33	163.33	9	5	110.00	------	----	106.00	88.88	304.88	6	5
Minnesota	31.20	------	----	27.50	58.70	35	18	50.00	------	----	66.67	116.67	32	22	50.00	------	----	7.50	111.11	168.61	34	31
Iowa	70.00	------	----	22.00	92.00	3	3	70.00	------	----	53.33	123.33	24	18	70.00	------	----	5.00	88.88	163.88	36	34
Missouri	10.00	11.44	----	11.00	32.44	49	49	30.00	16.44	----	26.67	73.11	49	49	30.00	16.44	----	------	44.44	90.88	49	49
Southeastern:																						
Arkansas	36.00	13.98	----	35.75	85.73	5	8	42.00	19.83	----	86.67	148.50	14	15	42.00	19.83	----	------	144.44	206.27	24	26
Louisiana	10.00	------	----	49.50	59.50	34	16	60.00	25.45	----	120.00	205.45	2	3	120.00	25.45	----	10.00	200.00	355.45	3	3
Oklahoma	22.40	------	.50	35.75	58.65	36	19	95.00	------	.50	86.67	182.17	5	2	95.00	------	.50	------	144.44	239.94	17	11
Texas	40.63	7.06	----	22.00	69.69	22	13	81.25	16.96	----	53.33	151.54	12	13	81.25	16.96	----	11.00	88.88	198.09	28	27
West Central:																						
North Dakota	28.50	------	----	22.00	50.50	43	33	50.50	------	----	53.33	103.83	43	27	50.50	------	----	50.00	88.88	189.38	29	25
South Dakota	37.50	------	----	22.00	59.50	33	15	37.50	------	95.00	53.33	185.83	4	1	37.50	------	----	95.00	88.88	221.38	19	15
Nebraska	12.00	22.22	----	33.00	67.22	26	40	80.00	48.42	----	80.00	208.42	1	7	80.00	48.42	----	10.00	133.33	271.75	10	13
Kansas	15.00	28.98	----	27.50	71.48	20	44	15.00	45.69	10.00	66.67	137.36	18	39	15.00	45.69	----	30.00	111.11	201.80	27	36
Mountain:																						
Montana	20.00	14.92	----	33.00	67.92	25	27	20.00	31.10	----	80.00	131.10	22	31	20.00	31.10	----	45.00	133.33	229.43	18	23
Idaho	20.00	------	----	33.00	53.00	40	28	35.00	------	----	80.00	115.00	35	23	45.00	------	----	------	133.33	178.33	32	28
Wyoming	15.00	19.32	----	22.00	56.32	38	46	15.00	19.32	----	53.33	87.65	47	47	15.00	19.32	----	58.90	88.88	182.10	30	35
Colorado	17.50	19.32	----	33.00	69.82	21	34	17.50	19.32	----	80.00	116.82	31	33	17.50	19.32	----	80.80	133.33	250.95	12	12
New Mexico	43.50	------	----	38.50	82.00	11	6	43.50	------	----	93.31	136.81	19	12	21.75	------	----	25.00	155.55	202.30	26	22
Arizona	29.00	23.00	----	27.50	79.50	14	22	29.00	23.00	----	66.67	118.67	30	34	29.00	23.00	----	175.00	111.11	338.11	4	4
Utah	25.00	19.64	.50	22.00	67.14	27	38	25.00	31.77	.50	53.33	110.60	40	46	25.00	31.77	.50	------	88.88	146.15	43	47
Nevada	18.90	37.75	----	24.75	81.40	13	41	18.90	37.75	----	60.00	116.65	34	45	18.90	37.75	----	99.05	100.00	255.70	11	17
Pacific:																						
Washington	17.50	------	15.75	35.75	69.00	24	9	30.00	------	15.75	86.67	132.42	20	14	30.00	------	15.75	15.00	144.44	205.19	25	21
Oregon	23.40	------	----	33.00	56.40	37	23	46.80	------	36.00	80.00	162.80	10	6	46.80	------	----	60.00	133.33	240.13	16	10
California	36.00	------	23.00	24.75	83.75	9	5	36.00	------	23.00	60.00	119.00	28	19	36.00	------	23.00	227.50	100.00	386.50	2	2

Table 6.—*Road-user and personal-property taxes on a single-unit van truck, 18,500 pounds gross vehicle weight*

Region and State	Private					Rank of State		Contract, for hire						Rank of State	
	Registration fee	Property tax	Other taxes and fees	Gasoline tax	Total	Total fees and taxes	Total, excluding property tax	Registration fee	Property tax	Other taxes and fees	Carrier taxes and fees	Gasoline tax	Total	Total fees and taxes	Total, excluding property tax
New England:															
Maine	$125.00	$55.63	------	$138.42	$319.05	9	11	$125.00	$55.63	-----	$5.00	$230.76	$416.39	22	25
New Hampshire	111.00	40.05	------	92.28	243.33	23	25	111.00	40.05	-----	2.00	153.84	306.89	31	37
Vermont	175.75	------	------	115.35	291.10	14	6	175.75	------	-----	------	192.30	368.05	25	21
Massachusetts	27.00	78.60	------	69.21	174.81	44	48	27.00	78.60	-----	5.00	115.38	225.98	46	48
Rhode Island	54.00	81.00	------	92.28	227.28	29	44	54.00	81.00	-----	5.00	153.84	293.84	33	45
Connecticut	55.50	90.87	------	92.28	238.65	26	43	55.50	90.87	-----	5.00	153.84	305.21	32	44
Middle Atlantic:															
New York	63.20	------	------	92.28	155.48	47	40	63.20	------	-----	------	153.84	217.04	47	41
New Jersey	80.00	------	$1.00	69.21	150.21	48	42	80.00	------	$1.00	------	115.38	196.38	48	47
Pennsylvania	70.00	------	------	115.35	185.35	42	32	70.00	------	-----	10.00	192.30	272.30	41	35
Delaware	69.00	------	------	115.35	184.35	43	33	69.00	------	-----	------	192.30	261.30	43	39
Maryland	75.00	20.00	------	115.35	210.35	34	29	75.00	20.00	-----	------	192.30	287.30	35	36
District of Columbia	50.00	53.36	1.00	92.28	196.64	38	45	50.00	53.36	1.00	------	153.84	258.20	44	46
West Virginia	78.00	111.25	------	115.35	304.60	10	28	156.00	111.25	-----	22.50	192.30	482.05	11	19
Southeastern:															
Virginia	45.60	59.40	------	138.42	243.42	22	34	45.60	59.40	-----	130.00	230.76	465.76	12	13
North Carolina	144.00	64.62	------	161.49	370.11	3	3	252.00	64.62	-----	------	269.22	585.84	4	5
South Carolina	125.00	63.20	1.00	138.42	327.62	8	10	125.00	63.20	1.00	150.00	230.76	569.96	6	6
Georgia	37.50	72.54	------	161.49	271.53	17	26	75.00	72.54	-----	25.00	269.22	441.76	18	20
Florida	79.00	------	.25	161.49	240.74	24	16	225.75	------	.25	250.50	269.22	745.72	1	1
Kentucky	112.00	116.25	.75	161.49	390.49	2	8	45.00	116.25	.50	121.00	269.22	551.97	8	9
Tennessee	80.00	------	.50	161.49	241.99	25	15	140.00	------	.50	12.50	269.22	422.22	21	11
Alabama	50.00	25.46	.75	138.42	214.63	33	30	50.00	25.46	.75	126.00	230.76	432.97	19	12
Mississippi	79.00	60.49	------	138.42	277.91	15	21	157.00	60.49	-----	13.00	230.76	461.25	13	15
East Central:															
Ohio	113.00	------	------	92.28	205.28	35	24	113.00	------	-----	20.00	153.84	286.84	36	32
Indiana	50.00	57.52	------	92.28	199.80	37	46	50.00	57.52	-----	12.00	153.84	273.36	40	42
Illinois	110.00	25.23	------	69.21	204.44	36	35	110.00	25.23	-----	------	115.38	250.61	45	40
Michigan	98.75	------	------	69.21	167.96	45	37	98.75	------	-----	50.00	115.38	264.13	42	38
Wisconsin	185.00	------	------	92.28	277.28	16	7	185.00	------	-----	190.00	153.84	528.84	9	4
Minnesota	80.00	------	------	115.35	195.35	39	27	80.00	------	-----	7.50	192.30	279.80	37	33
Iowa	155.00	------	------	92.28	247.28	21	14	155.00	------	-----	5.00	153.84	313.84	30	27
Missouri	40.00	18.50	------	46.14	104.64	49	49	40.00	18.50	-----	------	76.92	135.42	49	49
Southwestern:															
Arkansas	63.00	53.05	------	149.96	266.01	18	23	63.00	53.05	-----	------	250.00	366.05	26	28
Louisiana	120.00	25.45	------	207.63	353.08	7	2	240.00	25.45	-----	10.00	346.14	621.59	2	3
Oklahoma	145.00	------	.50	149.96	295.46	12	5	145.00	------	.50	------	250.00	395.50	23	16
Texas	129.50	43.09	------	92.28	264.87	19	19	129.50	43.09	-----	11.00	153.84	337.43	29	30
West Central:															
North Dakota	73.00	------	------	92.28	165.28	46	38	73.00	------	-----	50.00	153.84	276.84	39	34
South Dakota	87.50	------	185.00	92.28	364.78	4	1	87.50	------	-----	185.00	153.84	426.34	20	10
Nebraska	120.00	95.20	------	138.42	353.62	6	12	120.00	95.20	-----	10.00	230.76	455.96	14	24
Kansas	60.00	126.29	62.00	115.35	363.64	5	17	60.00	126.29	-----	125.00	192.30	503.59	10	17
Mountain:															
Montana	75.00	79.38	------	138.42	292.80	13	22	75.00	79.38	-----	60.00	230.76	445.14	17	22
Idaho	50.00	------	------	138.42	188.42	40	31	60.00	------	-----	------	230.76	290.76	34	31
Wyoming	40.00	53.40	------	92.28	185.68	41	47	40.00	53.40	-----	106.25	153.84	353.49	28	29
Colorado	25.00	53.40	------	138.42	216.82	32	39	25.00	53.40	-----	146.00	230.76	455.16	15	14
New Mexico	67.50	------	------	161.49	228.99	28	18	33.75	------	-----	62.50	269.22	365.47	27	23
Arizona	54.85	60.00	------	115.35	230.20	27	36	54.85	60.00	-----	250.00	192.30	557.15	7	7
Utah	60.00	64.63	.50	92.28	217.41	31	41	60.00	64.63	.50	------	153.84	278.97	38	43
Nevada	25.64	233.50	142.45	103.82	505.41	1	9	25.64	233.50	-----	142.45	173.07	574.66	5	26
Pacific:															
Washington	75.00	------	28.50	149.96	253.46	20	13	75.00	------	28.50	18.00	250.00	371.50	24	18
Oregon	71.10	------	90.00	138.42	299.52	11	4	71.10	------	-----	150.00	230.76	451.86	16	8
California	56.00	------	58.00	103.82	217.82	30	20	56.00	------	58.00	325.00	173.07	612.07	3	2

As a generalization, in the States in which manufacturer's rated capacity is the basis of the registration fee schedule, truck fees tend to be relatively low in all weight groups, and particularly so for heavy vehicles. Manufacturer's rated capacities, as generally used in the past, have lost their significance and usefulness as measures of actual carrying capacity, and in so doing have also lost most of their value as bases for taxation. Most States have converted to a much more realistic gross-weight tax basis. The establishment of uniform standards of applying gross vehicle weight ratings for all trucks has been under cooperative study by State and Federal authorities and by the truck industry for some time.

Farm Service Registrations

As stated previously, special "farm" service classifications, with reduced registration fees for farmers' trucks but without restriction as to the highways they may use, are in effect in 23 States. The provision for registration of farm trucks at half of the regular fee for private trucks is a common one, but several States allow considerably larger reductions, as may be seen in tables 4 and 5. In Kentucky, for instance, the regular registration fee for the stake truck with a gross vehicle weight rating of 12,500 pounds is $32, but a farmer can register the same truck for $4.50. The flat fee of $4.50 is applicable to farm trucks with gross vehicle weight of 22,000 pounds or less, but a 22,000-pound vehicle in private use requires a registration fee of $134. Farm trucks comprised 31 percent of all trucks registered in Kentucky in 1948. In Nebraska, the 12,500-pound gross-vehicle-weight stake truck requiring a registration fee of $80 for regular private use can be registered for $12 as a farm truck. In 1948, more than 49 percent of Nebraska's trucks were registered as farm trucks.

The numbers of trucks registered in the farm classification were reported separately in 1948 by only 15 States. In 9 of these 15 States farm truck registrations accounted for more than 30 percent of the total truck registrations. It should not be forgotten, however, that the special reduced rates for registration of farm trucks are in part compensated for by the established fact that farm trucks operate fewer miles per year than other trucks. Thus the reduction on a cents-per-mile basis is not as great as it might appear from a comparison of the registration fees in tables 4 and 5.

Road-User Taxes

While the differences in registration fees between vehicles and between States are of considerable significance, one of the purposes of this study was to present the road-user taxes so that they could be considered collectively as well as individually. With State gasoline taxes ranging from 2 to 9 cents a gallon, the effect of low registration-fee schedules is often compensated by correspondingly high gasoline-tax rates, and vice versa. This is illustrated by the situation in Vermont which, in 1948, had the highest average truck registration fee in the United States—$86, compared to less than $9 in Montana—and one of the highest fees for automobiles, but

Table 7.—*Road-user and personal-property taxes on a three-axle, tractor-semitrailer combination, 40,000 pounds gross vehicle weight*

Region and State	Private					Rank of State		Contract, for hire						Rank of State	
	Registration fee	Property tax	Other taxes and fees	Gasoline tax	Total	Total fees and taxes	Total, excluding property tax	Registration fee	Property tax	Other taxes and fees	Carrier taxes and fees	Gasoline tax	Total	Total fees and taxes	Total, excluding property tax
New England:															
Maine	$305.00	$62.50	------	$420.00	$787.50	11	11	$305.00	$62.50	------	$10.00	$540.00	$917.50	23	22
New Hampshire	240.00	74.39	------	280.00	594.39	29	31	240.00	74.39	------	2.00	360.00	676.39	37	38
Vermont	390.00	------	------	350.00	740.00	18	10	390.00	------	------	------	450.00	840.00	27	25
Massachusetts	61.00	145.99	------	210.00	416.99	45	49	61.00	145.99	------	5.00	270.00	481.99	47	48
Rhode Island	129.00	160.42	------	280.00	569.42	31	42	129.00	160.42	------	7.00	360.00	656.42	38	44
Connecticut	200.00	220.18	------	280.00	700.18	21	36	200.00	220.18	------	5.00	360.00	785.18	31	41
Middle Atlantic:															
New York	124.00	------	------	280.00	404.00	46	43	124.00	------	------	------	360.00	484.00	46	45
New Jersey	168.00	------	$2.00	210.00	380.00	48	46	168.00	------	$2.00	------	270.00	440.00	48	47
Pennsylvania	171.00	------	------	350.00	521.00	38	29	171.00	------	------	10.00	450.00	631.00	40	35
Delaware	150.00	------	------	350.00	500.00	42	33	150.00	------	------	------	450.00	600.00	43	39
Maryland	235.00	60.00	------	350.00	645.00	24	23	235.00	60.00	------	------	450.00	745.00	32	32
Dist. of Col.	100.00	95.87	2.00	280.00	477.87	43	45	100.00	95.87	2.00	------	360.00	557.87	45	46
West Virginia	61.25	206.62	------	350.00	617.87	28	41	122.50	206.62	------	30.00	450.00	809.12	30	37
Southeastern:															
Virginia	180.00	110.00	------	420.00	710.00	19	21	180.00	110.00	------	330.00	540.00	1,160.00	13	13
North Carolina	320.00	120.01	------	490.00	930.01	4	5	560.00	120.01	------	------	630.00	1,310.01	4	8
South Carolina	215.00	130.28	2.00	420.00	767.28	13	20	215.00	130.28	2.00	300.00	540.00	1,187.28	11	12
Georgia	110.00	164.92	------	490.00	764.92	15	22	225.00	164.92	------	25.00	630.00	1,044.92	17	20
Florida	192.50	------	.50	490.00	683.00	22	14	360.00	------	.50	450.50	630.00	1,441.00	1	1
Kentucky	350.00	202.50	.75	490.00	1,043.25	1	3	150.00	202.50	.50	320.00	630.00	1,303.00	5	10
Tennessee	275.00	------	.50	490.00	765.50	14	9	400.00	------	.50	17.50	630.00	1,048.00	16	14
Alabama	75.00	50.92	1.25	420.00	547.17	35	34	75.00	50.92	1.25	338.50	540.00	1,005.67	18	15
Mississippi	282.00	97.73	------	420.00	799.73	9	13	552.00	97.73	------	13.00	540.00	1,202.73	9	9
East Central:															
Ohio	220.00	------	------	280.00	500.00	41	32	220.00	------	------	30.00	360.00	610.00	42	36
Indiana	215.00	137.88	------	280.00	632.88	26	35	215.00	137.88	------	24.00	360.00	736.88	33	40
Illinois	250.00	57.82	------	210.00	517.82	40	39	250.00	57.82	------	------	270.00	577.82	44	42
Michigan	193.75	------	------	210.00	403.75	47	44	193.75	------	------	180.00	270.00	643.75	39	33
Wisconsin	240.00	------	------	280.00	520.00	39	30	240.00	------	------	590.00	360.00	1,190.00	10	7
Minnesota	360.00	------	------	350.00	710.00	20	12	360.00	------	------	7.50	450.00	817.50	29	27
Iowa	495.00	------	------	280.00	775.00	12	8	495.00	------	------	5.00	360.00	860.00	26	21
Missouri	153.00	34.94	------	140.00	327.94	49	48	153.00	34.94	------	------	180.00	367.94	49	49
Southwestern:															
Arkansas	205.00	102.69	------	455.00	762.69	17	18	205.00	102.69	------	------	585.00	892.69	25	28
Louisiana	240.00	59.38	------	630.00	929.38	5	2	480.00	59.38	------	10.00	810.00	1,359.38	3	3
Oklahoma	345.00	------	1.00	455.00	801.00	8	6	345.00	------	1.00	------	585.00	931.00	22	17
Texas	271.00	78.91	------	280.00	629.91	27	27	271.00	78.91	------	11.00	360.00	720.91	34	34
West Central:															
North Dakota	281.50	------	------	280.00	561.50	33	24	281.50	------	------	50.00	360.00	691.50	36	31
South Dakota	172.50	------	370.00	280.00	822.50	7	4	172.50	------	------	370.00	360.00	902.50	24	18
Nebraska	381.00	209.66	------	420.00	1,010.66	2	7	381.00	209.66	------	20.00	540.00	1,150.66	14	16
Kansas	130.00	234.56	74.00	350.00	788.56	10	26	130.00	234.56	------	270.00	450.00	1,084.56	15	23
Mountain:															
Montana	245.00	97.91	------	420.00	762.91	16	16	245.00	97.91	------	110.00	540.00	992.91	19	19
Idaho	125.00	------	------	420.00	545.00	36	28	160.00	------	------	------	540.00	700.00	35	30
Wyoming	80.00	99.18	------	280.00	459.18	44	47	80.00	99.18	------	400.94	360.00	940.12	21	24
Colorado	45.00	99.18	------	420.00	564.18	32	38	45.00	99.18	------	606.60	540.00	1,290.78	7	6
New Mexico	154.50	------	------	490.00	644.50	25	19	77.25	------	------	675.00	630.00	1,382.25	2	2
Arizona	115.75	111.80	------	350.00	577.55	30	37	115.75	111.80	------	500.00	450.00	1,177.55	12	11
Utah	150.00	100.78	.50	280.00	531.28	37	40	150.00	100.78	.50	------	360.00	611.28	41	43
Nevada	69.75	200.84	280.25	315.00	865.84	6	15	69.75	200.84	------	280.25	405.00	955.84	20	29
Pacific:															
Washington	156.00	------	53.25	455.00	664.25	23	17	156.00	------	53.25	36.00	585.00	830.25	28	26
Oregon	139.50	------	437.50	420.00	997.00	3	1	139.50	------	------	562.50	540.00	1,242.00	8	5
California	112.00	------	130.00	315.00	557.00	34	25	112.00	------	130.00	650.00	405.00	1,297.00	6	4

its total road-user revenue per vehicle was well down among the States as the result of a 4½-cent gasoline tax.

This leveling out in some States of registration fees and gasoline taxes, considered in combination, is further brought out in the present study. Kentucky, for instance, ranks 40th, 34th, 12th, and 5th in amounts of registration fees paid on the four commercial vehicles in private use, indicating a relatively low registration fee on the lightest truck and a gradual increase to a relatively high fee for the 40,000-pound tractor-semitrailer. When coupled with a 7-cent gasoline tax rate, the corresponding ranks of these vehicles among the States become much more uniform—12th, 17th, 8th, and 3rd, respectively. The weight of the gasoline tax payments compared with registration fees is also exemplified in the fact that the ranks by total road-user revenues are at a considerably higher level than the ranks of registration fees considered alone.

The tendency of a low gasoline tax rate to affect total road-user payments in the opposite direction is demonstrated by the fees paid in Ohio. The registration fees for the four private-use trucks rank 2nd, 9th, 11th, and 19th, indicating a high registration fee for the lightest truck and progressively lower fees, although above the national average, for the heavier vehicles. With the addition of gasoline tax payments at a 4-cent rate, total road-user revenues rank 18th, 24th, 24th, and 32nd among the States, a somewhat more uniform payment for all vehicles and a relatively lower total road-user tax payment, much nearer the median for the nation.

Other Taxes and Vehicle Types

The tables and charts presented in this article provide sufficient data to make general comparisons of the principal direct and recurring State taxes on motor vehicles, and are not intended to constitute a detailed analysis. A detailed study of all of the direct taxes that apply to motor vehicles would be an enormous undertaking. It is well to remember that there are taxes not included in this presentation that are closely associated with highway transportation and yield considerable amounts of revenue. Sales or use taxes (collected once on each vehicle) and drivers' licenses are two of the more important levied by the States, with titles and transfers also bringing in substantial amounts of revenue. Another large group of taxes omitted are those imposed by the Federal Government on gasoline, vehicles, and automotive products, which yielded nearly $1.4 billion during 1949. Also excluded are county, city, or other local registration fees and gasoline taxes, collected in some States.

It should also be remembered, as a practical matter, that the largest proportion of revenues for highways must be obtained primarily from automobiles and relatively light trucks, i. e., 1½-ton capacity or less. This group of automobiles and trucks includes approximately 98 percent of all vehicles registered and it is not possible to raise considerable amounts of money from additional taxes on the less than 2 percent that consists of the relatively heavy trucks.

(*Text continued on page 32.*)

Table 8.—*Road-user and personal-property taxes on a five-axle, tractor-semitrailer combination, contract, for hire; 64,000 pounds gross vehicle weight*

Region and State	Tractor-truck						Semitrailer					Combination						Rank of State	
	Registration fee	Property tax	Other taxes and fees	Carrier taxes and fees	Gasoline tax	Total	Registration fee	Property tax	Other taxes and fees	Carrier taxes and fees	Total	Registration fee	Property tax	Other taxes and fees	Carrier taxes and fees	Gasoline tax	Total	Total fees and taxes	Total, excluding property tax
New England:																			
Maine	------	------	------	-------	-------	-------	------	------	-----	-------	------	-------	------	------	-------	-------	-------	----	----
New Hampshire	------	------	------	-------	-------	-------	------	------	-----	-------	------	-------	------	------	-------	-------	-------	----	----
Vermont	------	------	------	-------	-------	-------	------	------	-----	-------	------	-------	------	------	-------	-------	-------	----	----
Massachusetts	------	------	------	-------	-------	-------	------	------	-----	-------	------	-------	------	------	-------	-------	-------	----	----
Rhode Island	------	------	------	-------	-------	-------	------	------	-----	-------	------	-------	------	------	-------	-------	-------	----	----
Connecticut	------	------	------	-------	-------	-------	------	------	-----	-------	------	-------	------	------	-------	-------	-------	----	----
Middle Atlantic:																			
New York	------	------	------	-------	-------	-------	------	------	-----	-------	------	-------	------	------	-------	-------	-------	----	----
New Jersey	------	------	------	-------	-------	-------	------	------	-----	-------	------	-------	------	------	-------	-------	-------	----	----
Pennsylvania	------	------	------	-------	-------	-------	------	------	-----	-------	------	-------	------	------	-------	-------	-------	----	----
Delaware	------	------	------	-------	-------	-------	------	------	-----	-------	------	-------	------	------	-------	-------	-------	----	----
Maryland	$35.00	$30.00	------	-------	$1,250.00	$1,315.00	$200.00	$30.00	-----	-------	$230.00	$235.00	$60.00	------	-------	$1,250.00	$1,545.00	21	20
District of Columbia	150.00	178.64	$1.00	-------	1,000.00	1,329.64	65.00	68.44	$1.00	-------	134.44	215.00	247.08	$2.00	-------	1,000.00	1,464.08	23	24
West Virginia	------	------	------	-------	-------	-------	------	------	-----	-------	------	-------	------	------	-------	-------	-------	----	----
Southeastern:																			
Virginia	------	------	------	-------	-------	-------	------	------	-----	-------	------	-------	------	------	-------	-------	-------	----	----
North Carolina	------	------	------	-------	-------	-------	------	------	-----	-------	------	-------	------	------	-------	-------	-------	----	----
South Carolina	250.00	258.00	1.00	$200.00	1,500.00	2,209.00	135.00	107.50	1.00	$200.00	443.50	385.00	365.50	2.00	$400.00	1,500.00	2,652.50	8	12
Georgia	------	------	------	-------	-------	-------	------	------	-----	-------	------	-------	------	------	-------	-------	-------	----	----
Florida	507.50	------	.25	1,500.50	1,750.00	3,758.25	178.00	------	.25	-------	178.25	685.50	------	.50	1,500.50	1,750.00	3,936.50	1	1
Kentucky	------	------	------	-------	-------	-------	------	------	-----	-------	------	-------	------	------	-------	-------	-------	----	----
Tennessee	------	------	------	-------	-------	-------	------	------	-----	-------	------	-------	------	------	-------	-------	-------	----	----
Alabama	------	------	------	-------	-------	-------	------	------	-----	-------	------	-------	------	------	-------	-------	-------	----	----
Mississippi	------	------	------	-------	-------	-------	------	------	-----	-------	------	-------	------	------	-------	-------	-------	----	----
East Central:																			
Ohio	357.50	------	------	30.00	1,000.00	1,387.50	133.00	------	-----	-------	133.00	490.50	------	------	30.00	1,000.00	1,520.50	22	19
Indiana	300.00	339.72	------	24.00	1,000.00	1,663.72	-------	112.95	-----	-------	112.95	300.00	452.67	------	24.00	1,000.00	1,776.67	19	23
Illinois	------	------	------	-------	-------	-------	------	------	-----	-------	------	-------	------	------	-------	-------	-------	----	----
Michigan	237.50	------	------	150.00	750.00	1,137.50	111.25	------	-----	150.00	261.25	348.75	------	------	300.00	750.00	1,398.75	24	22
Wisconsin	------	------	------	-------	-------	-------	------	------	-----	-------	------	-------	------	------	-------	-------	-------	----	----
Minnesota	710.00	------	------	-------	1,250.00	1,960.00	10.00	------	-----	7.50	17.50	720.00	------	------	7.50	1,250.00	1,977.50	16	15
Iowa	735.00	------	------	-------	1,000.00	1,735.00	60.00	------	-----	-------	60.00	795.00	------	------	5.00	1,000.00	1,800.00	18	18
Missouri	------	------	------	-------	-------	-------	------	------	-----	-------	------	-------	------	------	-------	-------	-------	----	----
Southwestern:																			
Arkansas	450.00	59.70	------	-------	1,625.00	2,134.70	5.00	48.10	-----	-------	53.10	455.00	107.08	------	-------	1,625.00	2,187.08	15	14
Louisiana	400.00	33.93	------	10.00	2,250.00	2,693.93	400.00	25.45	-----	-------	425.45	800.00	59.38	------	10.00	2,250.00	3,119.38	4	4
Oklahoma	------	------	------	-------	-------	-------	------	------	-----	-------	------	-------	------	------	-------	-------	-------	----	----
Texas	------	------	------	-------	-------	-------	------	------	-----	-------	------	-------	------	------	-------	-------	-------	----	----
West Central:																			
North Dakota	------	------	------	-------	-------	-------	------	------	-----	-------	------	-------	------	------	-------	-------	-------	----	----
South Dakota	562.50	------	------	415.00	1,000.00	1,977.50	80.00	------	-----	315.00	395.00	642.50	------	------	730.00	1,000.00	2,372.50	12	8
Nebraska	560.00	461.64	------	10.00	1,500.00	2,531.64	1.00	59.70	-----	10.00	70.70	561.00	521.34	------	20.00	1,500.00	2,602.34	9	13
Kansas	------	------	------	-------	-------	-------	------	------	-----	-------	------	-------	------	------	-------	-------	-------	----	----
Mountain:																			
Montana	300.00	198.46	------	210.00	1,500.00	2,208.46	300.00	66.16	-----	-------	366.16	600.00	264.62	------	210.00	1,500.00	2,574.62	11	11
Idaho	225.00	------	------	-------	1,500.00	1,725.00	150.00	------	-----	-------	150.00	375.00	------	------	-------	1,500.00	1,875.00	17	16
Wyoming	150.00	184.80	------	720.00	1,000.00	2,054.80	50.00	70.80	-----	419.69	540.49	200.00	255.60	------	1,139.69	1,000.00	2,595.29	10	10
Colorado	50.00	184.80	------	-------	1,500.00	1,734.80	50.00	70.80	-----	1,489.50	1,610.30	100.00	255.60	------	1,489.50	1,500.00	3,345.10	3	3
New Mexico	127.50	------	------	-------	1,750.00	1,877.50	44.50	------	-----	1,125.00	1,169.50	172.00	------	------	1,125.00	1,750.00	3,047.00	5	5
Arizona	188.50	208.00	------	1,000.00	1,250.00	2,646.50	92.50	79.80	-----	-------	172.30	281.00	287.80	------	1,000.00	1,250.00	2,818.80	7	7
Utah	295.00	273.30	.50	-------	1,000.00	1,568.80	105.00	96.40	-----	-------	201.40	400.00	369.70	.50	-------	1,000.00	1,770.20	20	21
Nevada	85.50	374.22	------	400.00	1,125.00	1,984.72	40.05	143.37	-----	157.95	341.37	125.55	517.59	------	557.95	1,125.00	2,326.09	14	17
Pacific:																			
Washington	355.50	------	85.50	25.00	1,625.00	2,091.00	225.50	------	33.00	22.00	280.50	581.00	------	118.50	47.00	1,625.00	2,371.50	13	9
Oregon	171.00	------	------	-------	1,500.00	1,671.00	80.10	------	-----	-------	80.10	251.10	------	------	1,800.00	1,500.00	3,551.10	2	2
California	206.00	------	170.00	-------	1,125.00	1,501.00	96.00	------	85.00	-------	181.00	302.00	------	255.00	1,300.00	1,125.00	2,982.00	6	6

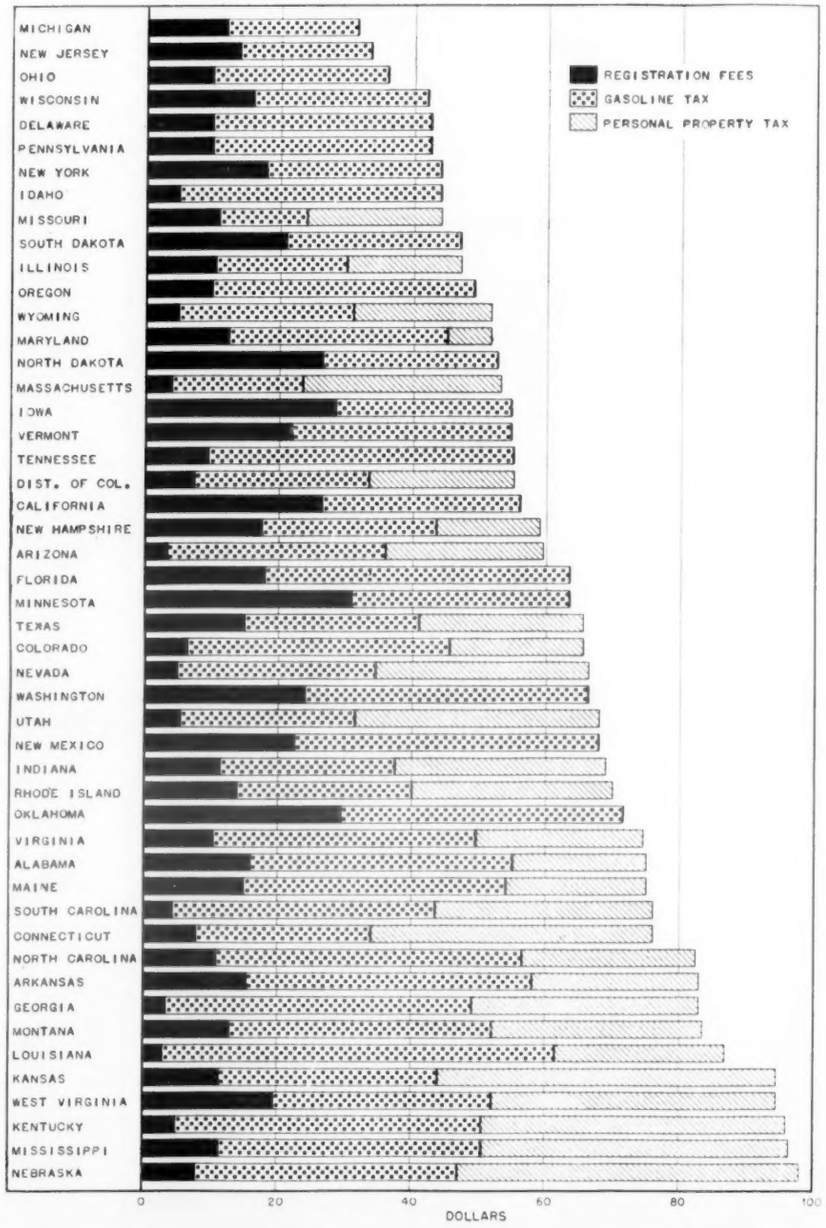

Figure 1.—Road-user and personal-property taxes on a passenger car (light- and medium-weight combined), in each State, ranked according to total tax.

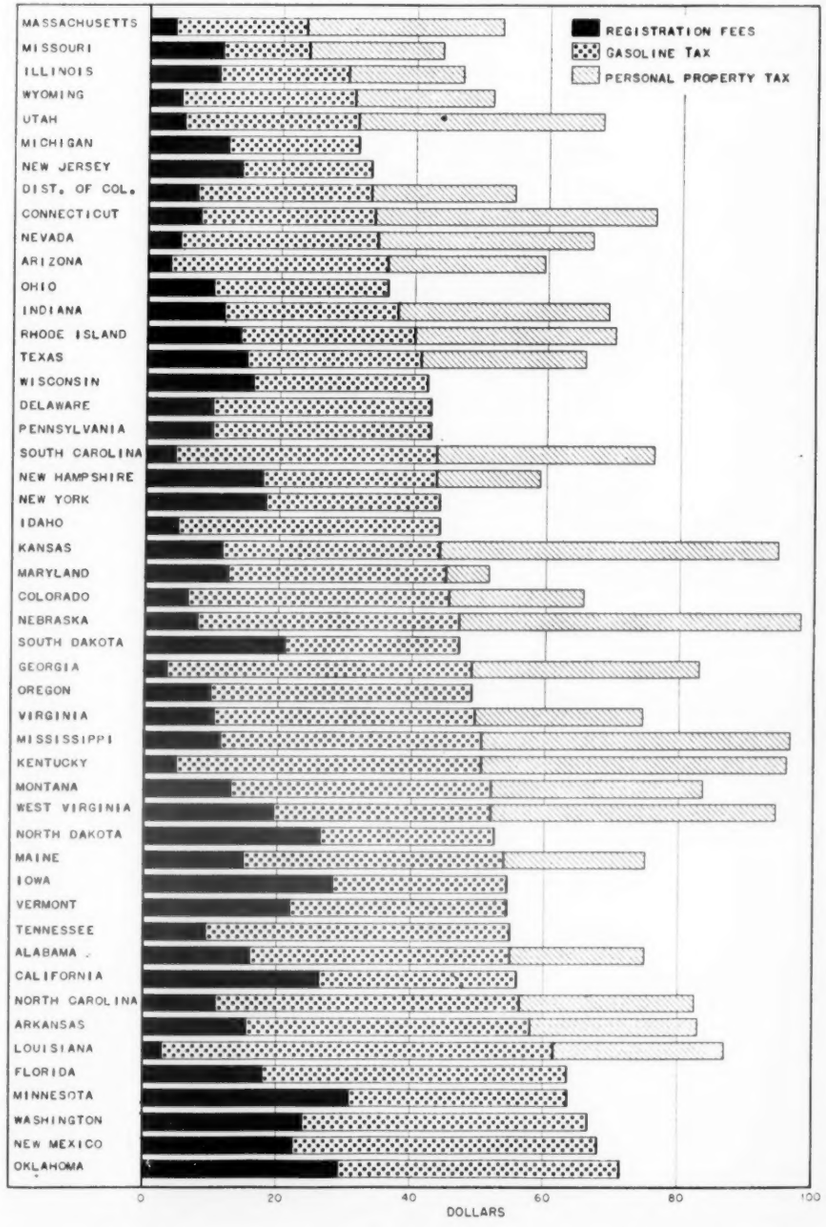

Figure 2.—Road-user and personal-property taxes on a passenger car (light- and medium-weight combined), in each State, ranked according to road-user taxes.

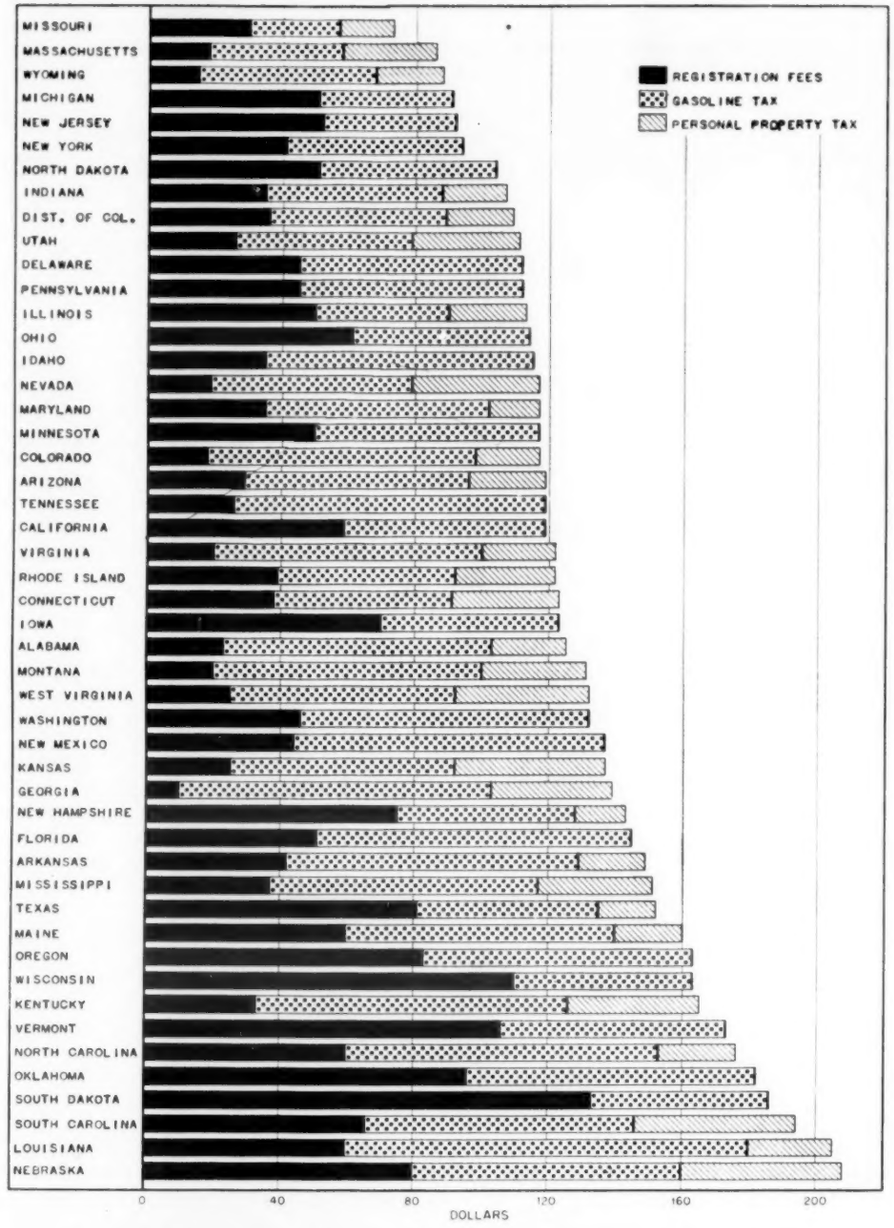

Figure 3.—Road-user and personal-property taxes on a single-unit stake truck in private use, in each State, ranked according to total tax.

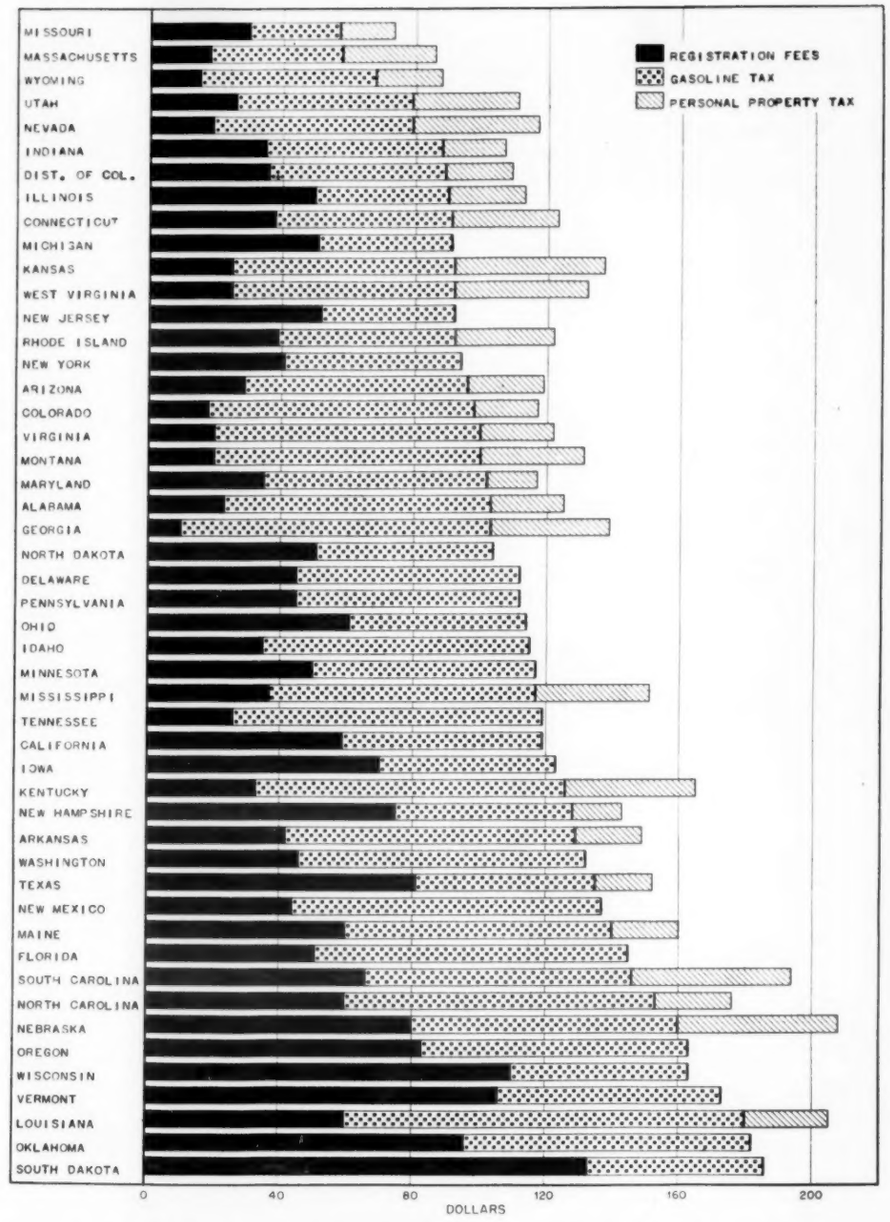

Figure 4.—Road-user and personal-property taxes on a single-unit stake truck in private use, in each State, ranked according to road-user taxes.

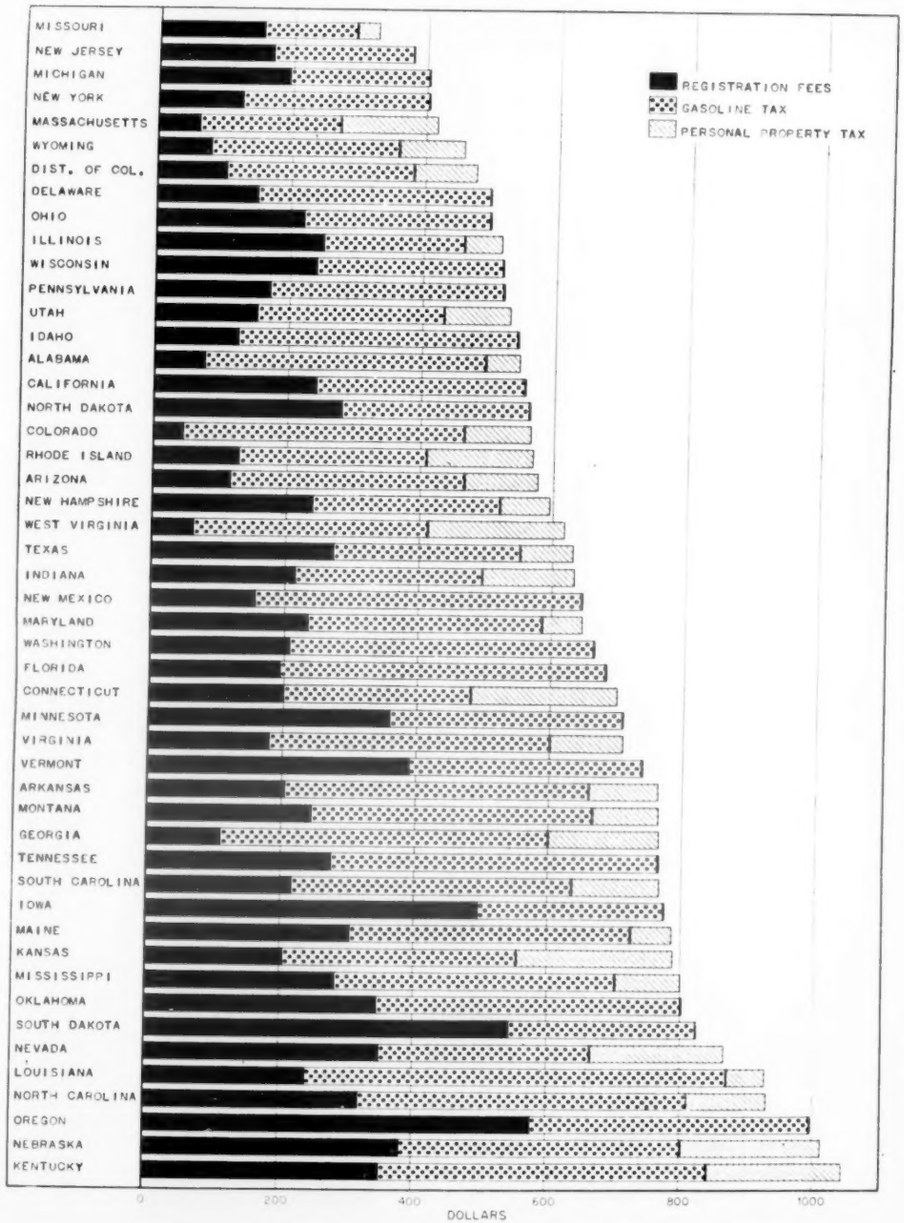

Figure 5.—Road-user and personal-property taxes on a three-axle tractor-semitrailer of 40,000 pounds gross weight, in each State, ranked according to total tax.

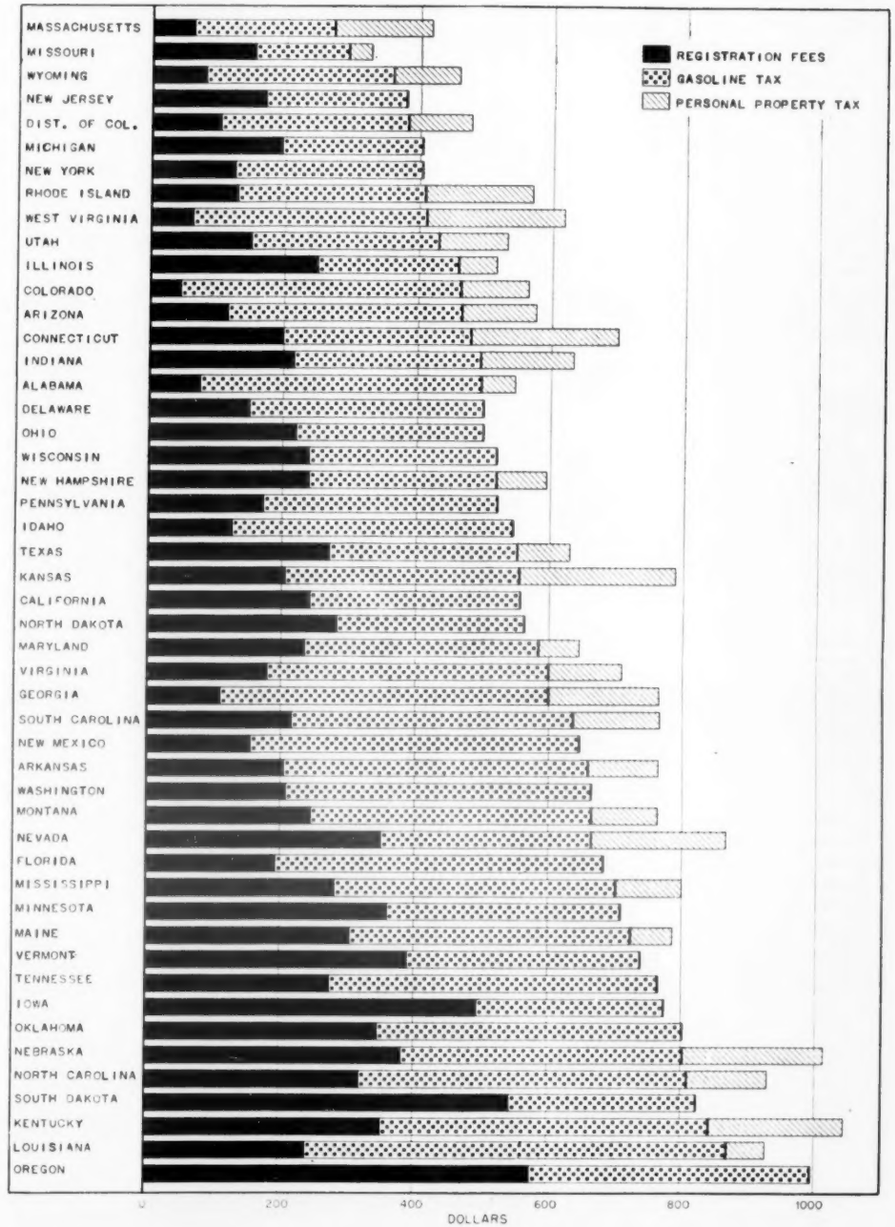

Figure 6.—Road-user and personal-property taxes on a three-axle tractor-semitrailer of 40,000 pounds gross weight, in each State, ranked according to road-user taxes.

The Identification of Rock Types

BY THE PHYSICAL RESEARCH BRANCH
BUREAU OF PUBLIC ROADS

Reported by D. O. WOOLF,
Senior Materials Engineer

The interest of highway engineers in selecting the best rock for use in different types of highway construction suggests the need for a simple method of identification of rock types which can be applied in the field. A suitable method which will assist the highway engineer in identifying most of the different types of rock with which he is concerned is presented in this article. An attempt has been made to present this method in simple terms for the benefit of those who are not familiar with expressions normally used in petrographic descriptions.

THE METHOD of identification of rock presented here is intended to be applied to pieces of a size large enough so that the structure of the rock can be observed clearly. In small pieces, the alinement, if any, of the minerals composing the rock may not be observed as readily as it would be in a larger piece. The user of this method is urged to obtain for study as large a piece of the rock as is convenient to handle. Pieces about 3 inches by 4 inches by 2 inches thick may be found to be suitable.

The equipment needed consists only of a knife blade of good steel, a small magnifying glass of 6 to 10 power, and a bottle of dilute hydrochloric acid, preferably with a dropper. If the acid is not available, household vinegar will usually serve in its place. Sometimes a fragment of quartz or a quartz crystal may be found useful, but generally crystals which are large enough to test with the quartz can be identified visually.

This method follows that given by Pirrson and Knopf,[1] which in turn was based on that given by Geikie in his Textbook of Geology.[2] It uses a combination of simple physical and chemical determinations to identify the rock. In some cases the individual minerals can be identified, and the rock can be named from a knowledge of its component minerals, their abundance, and the relative amounts of each. In other cases the minerals may be too small to identify with the hand lens, and recourse must be had to the general distribution of the minerals and to the structure of the rock. It should not be expected that this method will permit the identification of any and all rocks, but it is believed that the user will be able to identify the more common rocks used in highway construction. In those cases where the rock can not positively be identified, the user of this method should have no hesitancy in stating which type of rock the sample under study most closely resembles, and describing the particular features of the sample which are not in agreement with the characteristics of the type mentioned.

Table 1.—*General classification of rock*

Class	Type	Family
Igneous	Intrusive (coarse-grained)	Granite [1] Syenite [1] Diorite [1] Gabbro Peridotite Pyroxenite Hornblendite
	Extrusive (fine-grained)	Obsidian Pumice Tuff Rhyolite [1 2] Trachyte [1 2] Andesite [1 2] Basalt [1] Diabase
Sedimentary	Calcareous	Limestone Dolomite
	Siliceous	Shale Sandstone Chert Conglomerate [3] Breccia [3]
Metamorphic	Foliated	Gneiss Schist Amphibolite Slate
	Nonfoliated	Quartzite Marble Serpentinite

[1] Frequently occurs as a porphyritic rock.
[2] Included in general term "felsite" when constituent minerals cannot be determined quantitatively.
[3] May also be composed partially or entirely of calcareous materials.

General Classification

A general classification of rocks of interest in highway construction is given in table 1.[3] The rocks are first separated into three classes—igneous, sedimentary, and metamorphic—on the basis of their origin, and each class is subdivided with regard to physical characteristics or chemical composition.

In the igneous class, the intrusive or coarse-grained rocks include such familiar materials as granite and gabbro. These rocks were formed from molten material and cooled slowly so that the crystals composing the rock developed to an appreciable size. The extrusive rocks were also formed from molten material, but these cooled so rapidly that the crystals are very small. In a few cases, the molten material formed as a glass, resulting in obsidian or similar rocks. The fine-grained crystalline rocks include rhyolite, trachyte, andesite, basalt, and diabase. The first three of these rocks are sometimes grouped under a general family name of felsite which includes light- to medium-colored, very fine-grained igneous rocks. Basalt and diabase are frequently described in engineering terminology as "trap" rock.

The sedimentary class of rocks, formed by deposition of water- or wind-transported rock grains, is separated into two groups on the basis of the principal mineral component. The calcareous rocks, which are composed essentially of compounds of lime or magnesia, include limestone and dolomite. Sedimentary rocks, which are composed chiefly of silica, include shale, sandstone, and chert.

The metamorphic class is separated into two groups based on the structure of the rock. In the foliated or layered types are included gneiss, schist, and slate, while quartzite and marble are included in the nonfoliated type. The metamorphic class includes those rocks which have been formed from another type of rock by heat or pressure. For example, gneiss may be formed from granite, marble from limestone or dolomite, and quartzite from sandstone. Sometimes this alteration

Table 2.—*Rock-forming minerals*

Primary minerals	
Name	Composition
Quartz	Silicon dioxide.
Feldspar:	
Orthoclase	Silicate of potassium and aluminum.
Microcline	Silicate of potassium and aluminum.
Plagioclase	Silicate of sodium, calcium, and aluminum.
Pyroxene:	
Augite	Silicate of calcium, iron, magnesium, and aluminum.
Amphibole:	
Hornblende	Complex silicate principally of calcium, iron, magnesium, and aluminum.
Mica:	
Muscovite	Hydrous silicate of potassium and aluminum.
Biotite	Hydrous silicate of potassium, magnesium, iron, and aluminum.
Magnetite	Iron oxide.
Rock glass	Variable.
Garnet	Silicate of aluminum, iron, and calcium.
Olivine	Silicate of magnesium and iron.
Secondary minerals	
Name	Composition
Calcite	Calcium carbonate.
Dolomite	Calcium and magnesium carbonate.
Kaolin	Hydrous silicate of aluminum.
Chlorite	Hydrous silicate of iron, magnesium, and aluminum.
Epidote	Hydrous silicate of calcium, aluminum, and iron.
Limonite	Hydrous iron oxide.
Opal	Hydrous silicon dioxide.

[1] *Rocks and Rock Minerals*, by Louis V. Pirrson and Adolph Knopf, 3rd edition; John Wiley and Sons, Inc., New York; 1947.

[2] *Textbook of Geology*, by Sir Archibald Geikie, 3rd edition; MacMillan and Co., London; 1893.

[3] Based on table 2 in *Relation of Mineral Composition and Rock Structure to the Physical Properties of Road Materials*, by E. C. E. Lord; U. S. Department of Agriculture Bulletin No. 348; April 4, 1916.

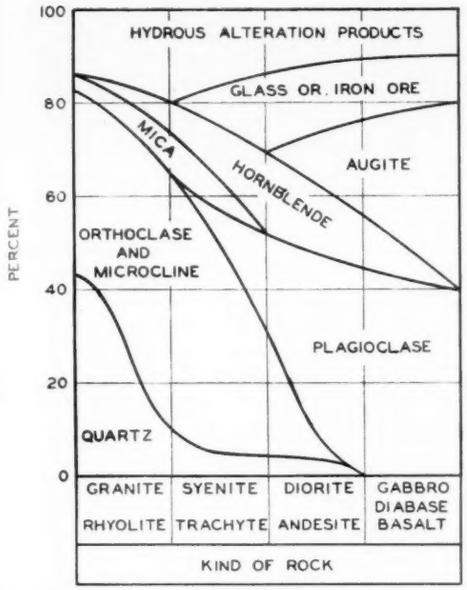

Figure 1.—Diagrammatic representation of the mineral composition of igneous rocks.

improves the quality of the rock, as in the case of quartzite, which is a much harder and tougher material than sandstone. In other cases, the reverse applies: marble generally is inferior to limestone or dolomite as an aggregate for highway construction.

Mineral Composition of Rocks

The more important rock-forming minerals are listed in table 2. These are separated into primary and secondary minerals depending upon whether they are found in the original igneous rocks or were derived by alteration of the minerals in these rocks.

The essential mineral composition of the more common rocks used in highway construction is given in table 3. This is a condensation of material given in United States Department of Agriculture Bulletin No. 348.[4] In table 3, the average percentage distribution of the minerals which are characteristic of each variety of rock is shown, together with incidental minerals which are indicated by values in parentheses. Minerals which are present in the rocks in amounts less than 3 percent are not mentioned separately but are grouped in the table under "remainder."

In figure 1, a graphical representation of the composition of igneous rocks is shown. This is based on the data given in table 3, but has been idealized to a certain extent for purposes of simplification. In the segment marked "glass or iron ore," the rock glass applies to the fine-grained extrusive rocks only.

The color of the rock furnishes some indication of the mineral content. If the rock is white or light in color, the predominant minerals probably are quartz and feldspar. Red, brown, green, gray, and black colors usually indicate the presence of minerals containing iron. In sedimentary rocks, gray or black colors may be caused by carbonaceous matter.

Classification by Geologic Type

It will be helpful if the user can classify rock with respect to its general geologic type, that is, whether the rock was formed directly from a molten mass (igneous class), or was formed by deposition of the rock grains transported by water or wind (sedimentary class), or was formed by the action of heat or pressure or both on previously existing rock (metamorphic class). Features which will assist in this classification of rock are the following:

[4] See footnote 3, page 44.

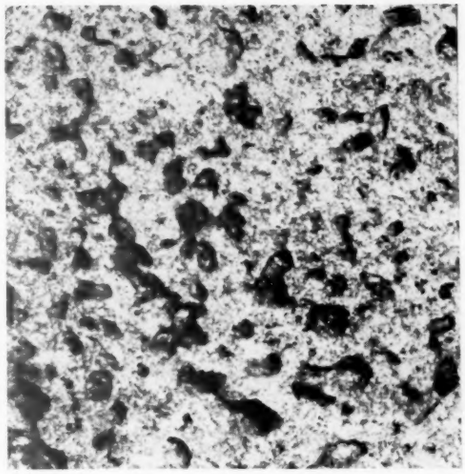

Figure 2.—A vesicular basalt (full size).

Igneous class:

- Absence of fossils.
- Presence of glass.
- Uniformity of structure.
- Interlocking crystals.

Sedimentary class:

- Rounded grains.
- Presence of fossils.
- Stratification in relatively thick layers.
- Abrupt changes in color from layer to layer.

Metamorphic class:

- Separation of crystals into approximately parallel layers.
- Formation in thin parallel layers.
- Broken readily into thin slabs.

All features mentioned for a given class probably will not be found in one single piece of rock, but one or more of those mentioned should be found.

Rock Structure

The structure of the rock is of considerable assistance in determining the general classification of the rock and also in determining the precise name for the material. Masses of rock which show a marked resemblance to columns are unquestionably of an igneous origin. Rock which is vesicular—that is, containing large or small cavities which sometimes are separated by thin walls of rock—is usually an igneous type. An example of this is shown in figure 2. In some igneous rocks these cavities are filled with a material which is of a different nature from that of the rock itself, and the rock is said to have an amygdoloidal structure.

Most types of metamorphic rocks show a peculiarity of structure which is described as foliation. Such rocks could as well be described as banded or layered, except that these terms imply an abrupt change in the appearance of the rock from one layer to the next. Bands and layers are frequently used in descriptions of sedimentary rocks. Three types of folia-

Table 3.—*Mineral composition of rocks*

Name of rock	Number of samples tested	Essential mineral composition, percent [1]													
		Quartz	Orthoclase Microcline	Plagioclase	Augite	Hornblende	Mica	Calcite	Dolomite	Chlorite	Kaolin	Epidote	Iron ore	Rock glass	Remainder
Igneous rocks:															
Granite	165	30	45	(8)	----	----	6	----	----	----	(6)	----	----	----	5
Biotite granite	51	27	41	9	----	----	11	----	----	----	(7)	----	----	----	5
Hornblende granite	20	23	34	12	----	13	4	----	----	----	(10)	----	----	----	4
Augite syenite	23	(4)	52	7	8	----	4	----	----	(3)	(11)	(3)	(4)	----	4
Diorite	75	8	7	30	----	27	(4)	----	----	(3)	(8)	(5)	(3)	----	5
Gabbro	50	----	----	44	28	9	----	----	----	(3)	(6)	----	----	----	10
Rhyolite	43	32	45	(3)	----	----	(5)	----	----	(4)	(3)	----	(4)	----	4
Trachyte	6	(3)	42	----	----	6	----	(3)	----	(3)	(14)	(8)	(7)	9	5
Andesite	67	----	----	48	14	3	----	----	----	(6)	----	(3)	(8)	12	6
Basalt	70	----	----	36	35	----	----	----	----	----	----	----	(3)	21	5
Altered basalt	196	----	----	32	31	----	----	----	----	(9)	(4)	----	(4)	12	8
Diabase	29	----	----	44	46	----	----	----	----	----	----	----	(4)	----	6
Altered diabase	231	----	----	35	26	----	----	----	----	(15)	(9)	----	(4)	----	11
Sedimentary rocks:															
Limestone	875	(6)	----	----	----	----	----	83	8	----	----	----	----	----	3
Dolomite	331	(5)	----	----	----	----	----	11	82	----	----	----	----	----	2
Sandstone	109	79	(5)	----	----	----	----	----	----	----	(4)	----	(9)	----	3
Feldspathic sandstone	191	35	26	----	----	----	----	(3)	----	(3)	(22)	----	(4)	----	7
Calcareous sandstone	53	46	(3)	----	----	----	----	42	----	----	----	----	(3)	----	6
Chert	62	93	----	----	----	----	----	----	----	----	----	----	----	----	[2] 7
Metamorphic rocks:															
Granite gneiss	107	37	35	(3)	----	----	18	----	----	----	----	----	----	----	7
Biotite gneiss	62	31	35	(5)	----	----	21	----	----	----	----	----	----	----	8
Hornblende gneiss	18	10	16	15	(3)	45	(4)	----	----	----	----	----	----	----	7
Mica schist	42	37	16	----	----	----	38	----	----	----	----	----	----	----	9
Biotite schist	17	34	13	(3)	----	----	41	----	----	----	----	----	----	----	9
Chlorite schist	23	11	----	10	----	(5)	----	----	----	39	----	28	(4)	----	3
Hornblende schist	68	10	(3)	12	----	61	----	----	----	----	----	(7)	----	----	7
Amphibolite	22	(3)	----	8	----	70	----	----	----	----	----	12	----	----	7
Slate	71	29	(4)	----	----	----	55	----	----	----	----	----	(5)	----	7
Quartzite	61	84	(3)	----	----	----	(4)	----	----	----	----	----	----	----	9
Feldspathic quartzite	22	46	27	----	----	----	(7)	----	----	(3)	(10)	----	----	----	7
Pyroxene quartzite	11	29	19	15	24	----	----	----	----	----	----	----	(5)	----	[3] 8
Marble	61	(3)	----	----	----	----	----	96	----	----	----	----	----	----	1

[1] Values shown in parentheses indicate minerals other than those essential for the classification of the rock.
[2] Includes 3 percent opal. [3] Includes 3 percent garnet.

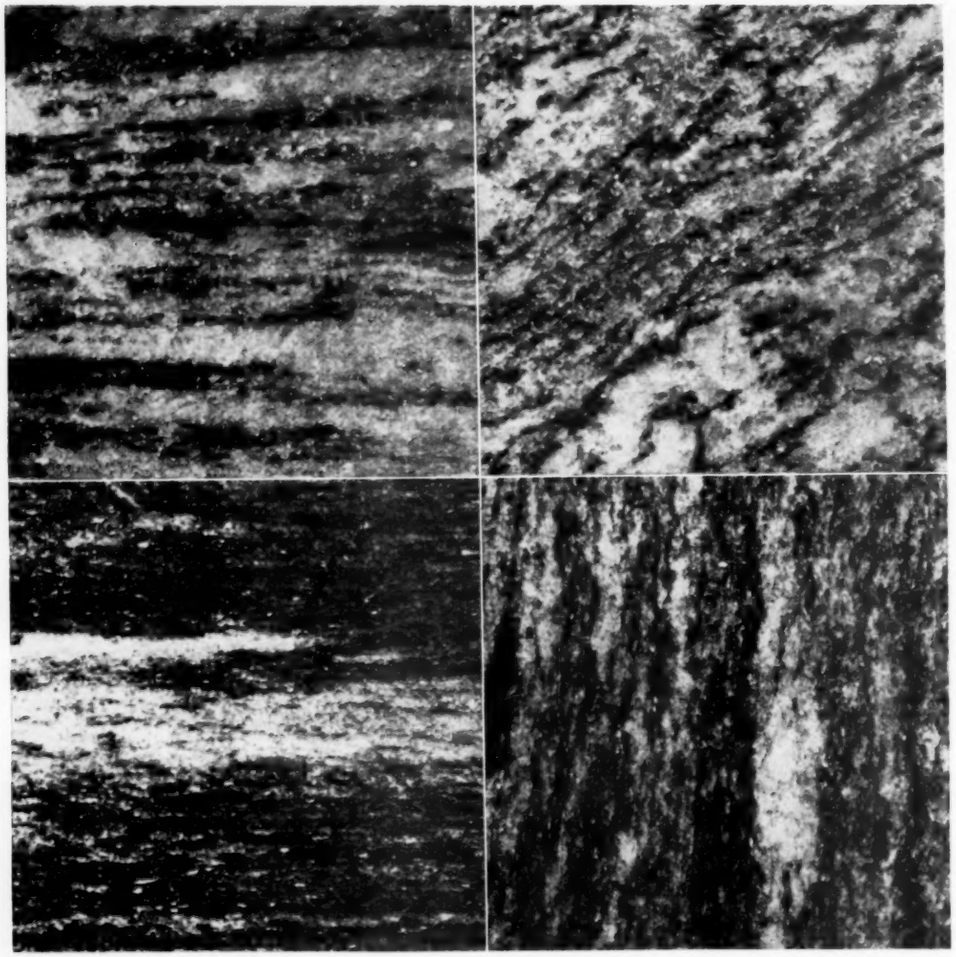

Figure 3.—Typical banding in foliated metamorphic rocks: granite gneiss (upper left); biotite gneiss (upper right); hornblende schist (lower left); mica schist (lower right).

tion—gneissoid, schistose, and slaty—are used in descriptions of metamorphic rocks. All of the foliated rocks will split or cleave more or less readily in one plane, and the type of foliation describes the degree of smoothness of the cleaved surface. Rocks with a gneissoid foliation have a rough, uneven surface while those with a slaty foliation have a very smooth cleaved surface. Schists or rocks with a schistose foliation have cleaved surfaces which are much smoother than the gneisses but not as smooth as the slates.

Under the effect of heat or pressure, the minerals in the foliated metamorphic rocks have been caused to arrange themselves in more or less parallel planes. The dark-colored minerals may separate from the light-colored minerals and form bands or streaks which are characteristic of certain foliated rocks. Figure 3 shows typical specimens of gneiss and schist. A close examination of such rocks will show that there is seldom an abrupt and complete separation between the dark- and light-colored minerals. Usually there is a zone of transition from light to dark bands, or the dark bands will contain an appreciable percentage of light-colored minerals. Banded sedimentary rocks which may be confused with the metamorphic rocks generally have an abrupt change in color or texture from one layer to the next, as shown in figure 4

Identification of Quartz and Feldspar

In the use of this method, it is necessary that quartz and feldspar be identified when these minerals occur in crystals or grains large enough to be seen with the aid of the hand lens. Their identification as constituents of rock may present some difficulties, since even in rocks of coarse grain these minerals may be so small that the usual determinations made on the ordinary mineral specimen frequently cannot be applied. For example, in hand specimens of minerals, feldspar may be identified in part by the fact that it is scratched by quartz. This test can seldom be applied to rock specimens due to the small size of the component crystals or grains. Recourse must be made to visual examination with reference to the color, shape, luster, and fracture of the grains.

In igneous rocks, quartz usually has a gray or smoky color, while feldspar is white, gray, or various shades of red. Grains of quartz are usually transparent or translucent, but those of feldspar are opaque. Quartz and feldspar are dissimilar in cleavage: if the grains are sufficiently large, those of feldspar will be found to break with flat surfaces forming an angle of about 90 degrees. By rotating the hand sample of rock so that light strikes the surface at different angles, the cleavage faces of feldspar crystals may be observed.

Table 4.—*Characteristics of feldspar and quartz as components of igneous rocks*

Characteristic	Feldspar	Quartz
Color	White, pink	Gray, smoky.
Transparency	Opaque	Translucent.
Luster	Porcelaneous to dull.	Glassy.
Cleavage	Good on two faces forming angles of about 90°.	None.
Form of crystal face.	Parallelopiped	Shapeless.
Multiple twinning.	Frequent	None.

A photograph showing the reflection of light from a cleavage face of a rather large crystal of feldspar in a specimen of granite is shown in figure 5. Quartz has no cleavage, and breaks with a conchoidal or shell-like fracture. Quartz has a glassy luster while feldspar has a luster more nearly like porcelain. Feldspar is affected by weathering, and the luster tends to become dull.

In the crystallization of the rock minerals from the mass of molten rock, the feldspars crystallize before quartz, and tend to occur in crystal form while quartz develops in more or less shapeless masses. Feldspar crystals frequently are compound structures of intergrown crystals which developed simultaneously The longitudinal axes of the portions of the crystals are parallel, but the transverse axes of one crystal segment are rotated through 180 degrees from those of the adjacent segment. At the junction between crystal segments, a plane of twinning is produced. In rock-making feldspars, these planes of twinning usually are very closely spaced, and the cleavage surface of a crystal of feldspar may appear to have been ruled with fine, parallel lines, as shown in figure 6. This twinning is not found in quartz.

A summarization of the principal characteristics of feldspar and quartz as components of igneous rocks is shown in table 4.

Identification of Other Minerals

In some cases, the common forms of the ferromagnesian minerals augite, hornblende, olivine, and biotite may also be identified in

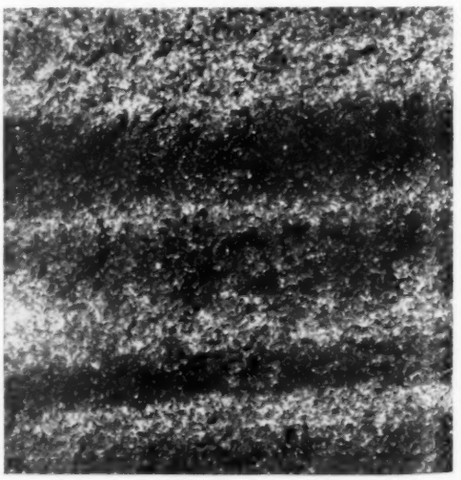

Figure 4.—Abrupt change in color between layers is characteristic of banded sedimentary rocks (banded sandstone).

rocks. The ferromagnesian minerals contain iron or magnesia or both as a principal component, and are identified by shape and color. In some rocks the minerals are sufficiently well crystallized for identification, but frequently they occur as grains or irregular masses and identification in the hand specimen may not be possible except by color.

Olivine is seldom found in well-developed crystals in rock. It occurs usually as grains or masses, and is identified by its color which varies from an olive green to a yellow green.

Augite and hornblende are the more common varieties of two large families of minerals, the pyroxenes and the amphiboles. Both augite and hornblende have a dark green to black color, and both frequently occur as grains or masses in rock. Identification of these minerals in the hand specimen depends upon whether the crystal shape can be determined. Augite tends to develop in short, thick crystals with a square or rectangular cross section. Hornblende commonly occurs as long, slender blades with irregular ends, and the cross section has a diamond shape with the acute angles replaced by parallel planes at right angles to the longer transverse axis of the crystal. Biotite is black mica, and is recognized by its black, shining color, its softness, and its occurrence as irregular flakes or scales in granites, syenites, and metamorphic rocks.

System for Rock Identification

The system for the identification of rock is shown in tabular form on page 48. In this method, all considerations are based on the appearance or character of newly fractured surfaces of the unweathered rock. In determinations of gravel, many pieces may be found to be weathered, and some modifications of the characteristics mentioned may be expected. For example, pieces of feldspar in gravel may have a dull luster, and some pieces may be so soft that they can be scratched with the knife.

The first determination in the system is the preliminary classification by which the specimen is placed in one of five general groups.

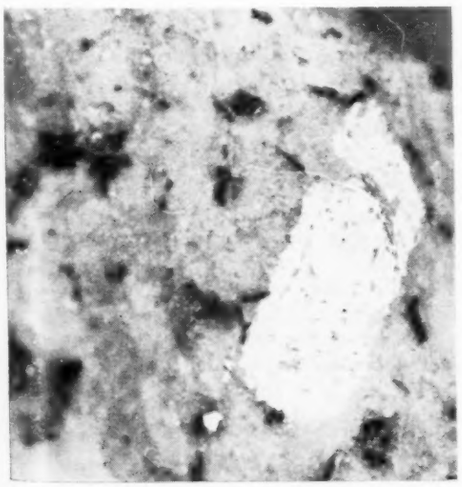

Figure 5.—Reflection of light from a cleavage face of a feldspar crystal in granite (about 2X).

When a determination of the lithological composition of a gravel is made, it is believed to be most desirable to separate the entire sample into the various general groups, and to examine each group of particles as an entity, subdividing each by the methods described. This should permit the identification to be performed most rapidly, and should group individual particles which show variations from a given class of rock due to slight differences in color, texture, or the effects of weathering.

In group I, glassy rocks, quartz is included as a rock. Actually this is not correct as quartz is a mineral, differing from rock in that it has a chemical composition expressible by a formula and also has a definite crystalline structure. However, quartz does occur in sufficiently large masses so that it is quarried as a rock, and is the most common material in a large percentage of gravels used for construction purposes. Due to these reasons, quartz is included in the table.

Subgroup II B, covering hard, fine-grained rocks, contains some types of rock which lately have become of considerable interest to those concerned with the durability of portland

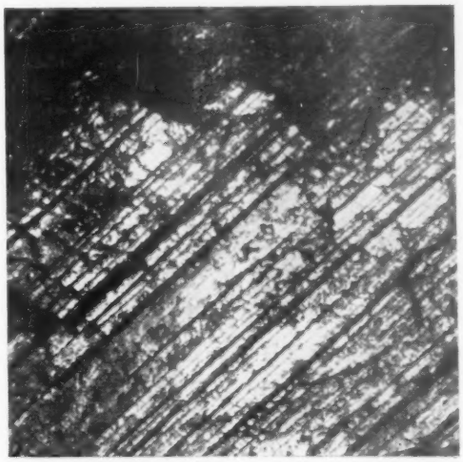

Figure 6.—Planes of twinning in feldspar produce an appearance of fine, parallel lines (about 3X).

cement concrete. Included in the general term "felsite" are a number of varieties of rock which may be chemically reactive to a detrimental degree with the alkali in cement. These include rhyolite, trachyte, and andesite. The identification of these rocks requires that both the kind and amount of feldspar present be determined. This determination cannot be made on the hand specimen, and the practice of grouping all fine-grained, light- or medium-colored, igneous rocks containing feldspar as a major constituent under the general term of felsite has been adopted. This is believed to be a sound procedure, as the various rocks so grouped appear to have essentially the same properties from the engineering viewpoint.

In subgroup III B, item 5, separation between sandstone and quartzite is made by examination of the plane of fracture of the rock. If the fracture is around the grains of quartz, the rock is sandstone. If the fracture passes through the grains, or through an

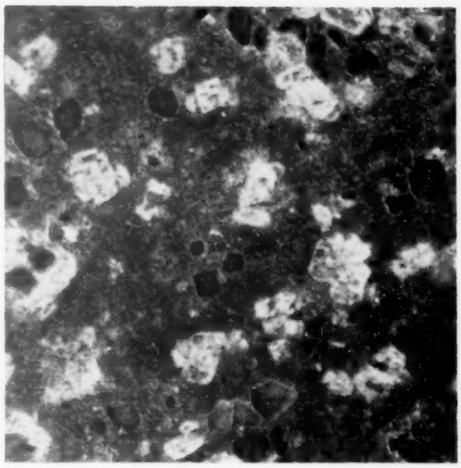

Figure 7.—Porphyritic granite (full size).

appreciable percentage of the grains, the rock is quartzite.

Subgroup III C covers rocks of a porphyritic texture as shown in figure 7. Originally, a porphyry referred to a rock composed of feldspar crystals embedded in a compact, dark red or purple groundmass. This name now refers to rocks containing large crystals of any kind, either well-formed or corroded to a rounded or irregular shape, which are embedded in a more finely crystalline or glassy groundmass of any color. A porphyry could refer to a rock containing crystals as big as an inch long which are embedded in a groundmass of crystals one-fourth inch in size; or it could refer to a rock containing crystals one-tenth of an inch in size embedded in a groundmass of barely visible crystals. In the laboratories of the Bureau of Public Roads, the name porphyry is used to refer to a rock containing numerous and more or less uniformly distributed crystals over one-eighth inch in size embedded in a groundmass so fine-grained that the individual grains are not recognized by the unaided eye.

Kemp [5] states that porphyries are commonly classified from the larger crystals (phenocrysts), with little regard for the composition of the groundmass even though the latter comprises over half of the rock. If the groundmass is of very fine grain, no other practice than that mentioned above can be followed without the use of the petrographic microscope or analysis by chemical methods.

In group IV, foliated rocks, it is doubted that the many varieties of schist can always be determined in the hand specimen. A few of the more common varieties are mentioned. There are many others, depending upon the presence of some mineral which may be in sufficient quantity or have certain unique properties to warrant its use as a modifier of the general term, schist. Most schists have about the same physical properties and the identification of the rock by this name alone may usually be sufficient.

In group IV, item 2(b), hornblende schists contain a small amount of quartz whereas

(*Text continued on page 52.*)

[5] *A Handbook of Rocks*, by J. F. Kemp; 6th edition, revised by F. F. Grout; D. Van Nostrand Co. Inc., New York; 1942.

PRELIMINARY CLASSIFICATION

Group I.—Glassy, wholly or partly.
Group II.—Not glassy; dull or stony; homogeneous; so fine-grained that grains cannot be recognized.
Group III.—Distinctly granular.
Group IV.—Distinctly foliated; no effervescence with acid.
Group V.—Clearly fragmental in composition; rounded or angular pieces or grains cemented together.

GROUP I.—GLASSY ROCKS

1. Glassy luster; hard; conchoidal fracture; colorless to white or smoky gray; generally brittle. *Quartz.*
2. Solid glass; may have spherical inclusions; brilliant vitreous luster; generally black. *Obsidian.*
3. Cellular or frothy glass. *Pumice.*

GROUP II.—DULL OR STONY, VERY FINE-GRAINED ROCKS

SUBGROUP II A.—Not scratched by fingernail, but readily scratched with knife.

1. Particles almost imperceptible; dull luster; homogeneous; clay odor; little if any effervescence with acid; laminated structure; breaks into flakes. *Shale.*
2. Little if any clay odor; brisk effervescence with acid. *Limestone.*
3. Little if any clay odor; brisk effervescence with acid only when rock is powdered or acid is heated. *Dolomite.*
4. Soapy or greasy feel; translucent on thin edges; green to black; no effervescence. *Serpentinite.*

SUBGROUP II B.—Not scratched with the knife or scratched only with difficulty; no effervescence with acid.

1. Light to gray color; clay odor possible; may have a banded flow structure. *Felsite.*
2. Very hard; pale colors to black; no clay odor; conchoidal fracture; waxy or horny appearance. *Chert.*
   If dark gray to black, *Flint.*
3. Heavy; dark color; may have cellular structure; may contain small cavities filled with crystalline minerals. *Basalt.*

GROUP III.—GRANULAR ROCKS

SUBGROUP III A.—Easily scratched with the knife.

1. Brisk effervescence with acid. *Limestone* or *Marble.*
2. Brisk effervescence only with warm acid, or with powdered rock. *Dolomitic marble.*

SUBGROUP III B.—Hard; not scratched with knife or scratched with difficulty; grains of approximately equal size.

1. Mainly quartz and feldspar; usually light colored, sometimes pinkish. *Granite.*
2. Mainly feldspar; little quartz (less than 5 percent); light colors of nearly white to light gray or pink. *Syenite.*
3. Feldspar and a dark ferromagnesian mineral.
   (a) Major constituent feldspar; rock of medium color. *Diorite.*
   (b) Ferromagnesian mineral equal to or in excess of feldspar; rock of dark color.
      (1) Grains just large enough to be recognized by the unaided eye. *Diabase.*
      (2) Coarse-grained rock. *Gabbro.*
4. Mainly ferromagnesian minerals; generally dark green to black.
   (a) Predominant olivine with pyroxene or hornblende. *Peridotite.*
   (b) Predominant augite. *Pyroxenite.*
   (c) Predominant hornblende. *Hornblendite.*

GROUP III.—Continued

5. Mainly quartz.
   (a) Fracture around grains. *Sandstone.*
   (b) Fracture through all or through an appreciable percentage of grains. *Quartzite.*

SUBGROUP III C.—Hard; not scratched with knife or scratched with difficulty; large distinct crystals in finer groundmass.

1. Crystals of feldspar and quartz with some of a ferromagnesian mineral (generally biotite) in a light-colored groundmass (of feldspar and quartz). *Granite porphyry.*
2. Crystals of feldspar and usually a ferromagnesian mineral in a light-colored groundmass (of feldspar). *Syenite porphyry.*
3. Crystals of ferromagnesian minerals, or of striated feldspar, or both, in a medium-colored groundmass (of feldspar and ferromagnesian minerals). *Diorite porphyry.*
4. Crystals of quartz, or feldspar, or both, generally with a ferromagnesian mineral, in a predominant, fine-grained groundmass of light color. *Felsite porphyry.*
5. Crystals of feldspar, or of a ferromagnesian mineral, or both, in a fine-grained, dark or black, heavy groundmass. *Basalt porphyry.*

GROUP IV.—FOLIATED ROCKS

1. Medium to coarse grain; roughly foliated. *Gneiss.*
2. More finely grained and foliated. *Schist.*
   (a) Consists mainly or largely of mica with some quartz. *Mica schist.*
   (b) Medium green to black; consists mostly of a felted or matted mass of small, bladed or needle-like crystals arranged in one general direction. *Hornblende schist* or *amphibolite.*
   (c) Glassy or silky luster on foliation surfaces; splits readily into thin pieces. *Sericite schist.*
   (d) Soft, greasy feel; marks cloth; easily scratched with fingernail; whitish to light gray, or green. *Talc schist.*
   (e) Smooth feel; soft; glimmering luster; green to dark green. *Chlorite schist.*
3. Very fine grain; splits easily into thin slabs; usually dark gray, green, or black. *Slate.*

GROUP V.—FRAGMENTAL

1. Rounded pebbles embedded in some type of a cementing medium. *Conglomerate.*
2. Angular fragments embedded in a cementing medium. *Breccia.*
3. Fragments of volcanic (fine-grained or glassy) rocks embedded in compacted volcanic ash. *Volcanic tuff* or *Volcanic breccia.*
4. Quartz grains, rounded or angular, cemented together. *Sandstone.*
5. Quartz and feldspar grains cemented together to resemble the appearance of granite. *Arkose* (feldspathic sandstone).

U. S. GOVERNMENT PRINTING OFFICE: 1950

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STATUS OF FEDERAL-AID HIGHWAY PROGRAM

AS OF APRIL 30, 1950

[Thousand dollars]

State	Unprogrammed balances	Active program											
		Programmed only			Plans approved, construction not started			Construction under way			Total		
		Total cost	Federal funds	Miles	Total cost	Federal funds	Miles	Total cost	Federal funds	Miles	Total cost	Federal funds	Miles
Alabama	$14,585	$13,733	$7,031	354.9	$5,182	$2,501	161.0	$11,860	$6,161	275.3	$30,775	$15,693	791.2
Arizona	2,050	5,093	3,544	123.4	1,160	830	35.9	5,513	3,782	83.4	11,766	8,156	242.7
Arkansas	2,582	16,087	8,683	450.3	6,756	3,294	149.7	12,563	6,302	290.5	35,406	18,279	890.5
California	3,901	45,691	18,098	325.9	6,418	3,072	65.0	39,877	19,785	191.2	91,986	40,955	582.1
Colorado	5,335	4,578	2,520	178.5	1,615	1,037	46.2	15,229	8,779	285.9	21,422	12,336	510.6
Connecticut	2,809	11,315	5,442	24.7	2,681	1,410	8.8	6,718	3,843	7.3	20,714	10,695	40.8
Delaware	1,238	4,685	2,340	55.5	2,152	1,028	9.8	3,185	1,512	49.6	10,022	4,880	114.9
Florida	8,167	13,483	6,812	355.8	4,426	2,652	115.5	10,060	4,759	267.6	27,969	14,223	738.9
Georgia	6,224	16,797	8,766	558.4	5,814	3,005	135.4	38,335	18,036	629.4	60,946	29,807	1,323.2
Idaho	5,917	8,637	5,426	379.9	2,538	1,564	74.2	4,689	2,918	116.0	15,864	9,908	570.1
Illinois	26,808	43,196	22,538	367.7	12,708	6,414	167.2	45,074	21,512	286.9	100,978	50,464	821.8
Indiana	18,382	19,196	9,511	97.0	5,293	2,533	38.0	12,854	7,228	38.7	37,343	19,272	173.7
Iowa	4,310	18,414	8,212	913.4	7,230	3,204	348.5	16,039	7,934	473.7	41,683	19,350	1,735.6
Kansas	6,066	11,471	5,765	1,314.3	5,490	2,756	458.5	14,516	7,467	709.7	31,477	15,988	2,482.5
Kentucky	2,371	19,227	9,518	331.4	8,219	4,157	141.4	13,987	6,831	229.2	41,433	20,506	702.0
Louisiana	7,328	22,263	10,794	213.2	5,362	2,617	67.9	16,811	8,475	175.7	44,436	21,886	456.8
Maine	2,084	10,795	5,843	133.6	763	378	8.3	5,633	2,799	77.7	17,191	9,020	219.6
Maryland	1,802	10,032	4,795	48.9	2,016	832	14.0	15,762	7,674	53.5	27,810	13,301	116.4
Massachusetts	1,852	17,982	7,673	22.6	16,207	7,185	18.4	50,774	24,265	43.8	84,963	39,123	84.8
Michigan	11,456	16,037	8,321	618.0	7,995	4,008	131.8	38,682	15,593	173.1	62,714	27,922	922.9
Minnesota	2,381	20,209	10,513	1,753.6	9,181	4,832	596.9	14,826	7,860	143.3	44,216	23,205	2,493.8
Mississippi	15,066	461	235	24.8	1,470	731	40.6	7,179	3,740	190.6	9,110	4,706	255.4
Missouri	7,215	35,994	18,663	1,029.1	14,569	6,073	299.2	23,695	12,474	511.6	74,258	37,210	1,839.9
Montana	6,050	18,417	9,874	752.9	4,496	2,605	132.9	11,168	6,987	255.8	34,081	19,466	1,141.6
Nebraska	7,102	17,503	9,097	653.3	6,286	3,158	172.9	10,459	6,160	209.3	34,248	18,415	1,035.5
Nevada	3,046	4,939	4,071	125.5	332	271	11.6	4,698	3,847	144.5	9,969	8,189	281.6
New Hampshire	2,396	5,537	2,754	53.7	1,645	806	14.0	2,009	951	11.4	9,191	4,511	79.1
New Jersey	2,293	14,054	6,927	23.2	3,618	1,809	3.5	18,667	8,912	30.4	36,339	17,648	57.1
New Mexico	1,939	11,110	7,087	397.4	2,129	1,386	116.4	8,947	5,805	274.4	22,186	14,278	788.2
New York	34,277	81,708	42,897	290.2	22,756	11,443	68.4	86,876	43,337	155.1	191,340	97,677	513.7
North Carolina	6,448	21,839	10,679	628.8	5,089	2,411	154.7	18,893	9,103	431.5	45,821	22,193	1,215.0
North Dakota	4,061	10,238	5,268	1,576.0	6,155	3,154	342.3	6,457	3,401	473.0	22,850	11,823	2,391.3
Ohio	7,712	70,663	34,255	393.3	15,939	7,620	89.4	31,883	15,727	149.9	118,485	57,602	632.6
Oklahoma	1,533	28,194	14,963	548.1	9,266	4,494	265.1	13,506	6,657	329.1	50,966	26,114	1,142.3
Oregon	1,141	9,303	5,415	160.7	4,289	2,509	96.1	10,650	5,721	120.1	24,242	13,645	376.9
Pennsylvania	18,904	20,048	9,024	56.3	16,277	8,359	50.2	72,649	35,597	177.6	108,974	52,980	284.1
Rhode Island	218	9,777	4,976	67.0	1,680	816	1.8	9,574	4,871	5.1	21,031	10,663	73.9
South Carolina	4,959	6,460	3,247	253.3	2,854	1,475	145.6	11,777	5,906	502.3	21,091	10,628	901.2
South Dakota	2,849	12,615	7,323	1,163.7	4,285	2,696	460.8	5,396	3,277	349.6	22,296	13,296	1,974.1
Tennessee	957	23,281	11,285	619.2	7,515	3,496	161.5	15,278	7,096	276.4	46,074	21,877	1,057.1
Texas	13,027	6,552	3,477	524.9	12,862	6,330	686.5	60,011	27,976	1,728.8	79,425	37,783	2,940.2
Utah	2,530	4,679	3,435	153.1	1,867	1,376	84.8	5,472	4,001	112.6	12,018	8,812	350.5
Vermont	1,285	4,117	2,243	41.7	287	142	2.6	4,110	1,884	40.2	8,514	4,269	84.5
Virginia	9,821	20,240	10,255	541.2	5,150	2,442	151.8	14,383	7,138	230.8	39,773	19,835	923.8
Washington	2,387	15,361	7,263	154.8	3,157	1,616	67.5	16,403	7,245	113.0	34,921	16,124	335.3
West Virginia	2,699	16,297	6,904	176.5	3,218	1,657	46.1	8,988	4,448	51.1	28,503	13,009	273.7
Wisconsin	10,839	25,436	12,866	597.0	5,424	2,539	114.4	12,214	6,054	289.5	43,074	21,459	1,090.9
Wyoming	817	4,319	2,645	121.3	2,436	1,558	120.6	7,608	5,013	259.9	14,363	9,216	501.8
Hawaii	1,642	7,945	3,620	31.2	2,395	1,076	6.9	4,482	2,230	16.8	14,822	6,926	54.9
District of Columbia	1,631	5,770	3,097	8.0				1,210	577	.9	6,980	3,674	8.9
Puerto Rico	5,147	7,240	3,289	29.0	3,162	1,454	10.9	9,444	3,785	50.5	19,846	8,528	90.4
Total	317,630	869,018	439,279	19,816.2	289,814	144,811	6,620.9	907,073	453,435	12,093.3	2,065,905	1,037,525	38,530.4